كتاب تجارب معمل

القياسات الإلكترونية

أولاً: بيانات المعمل الأساسية

اسم المعمل: معمل القياسات الإلكترونية

القسم العلمي: هندسة الإلكترونيات والاتصالات

المشرف: د./ محمد المرسي

مهندس المعمل: د./ مجدي محمد فاضل

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التليفون: 1389

الموقع بالنسبة للكلية: المعامل البحرية بالكلية – الطابق الثاني علوي.

مساحة المعمل: 127 م ^{2}

ثانياً: قائمة بالأجهزة والمعدات الموجودة بالمعمل:

Serial Number	العدد	اسم الجهاز	م
	10	Two channel Oscilloscope.	1
	10	Function generator.	2
	10	Dual power supply.	3
	15	Digital multimeter.	4
	20	Test board.	5
	5	Side cutter (قصافة)	6
	5	Pliers (زردية)	7

ثالثاً: قائمة بالتجارب التي تؤدي داخل المعمل:

م	التجربة	الغرض منها
1	Bipolar Junction Transistor (BJT) Amplifiers in Mid-Band Range.	تدريب الطلاب على كيفية الاستفادة من Active Components وتوظيفها لعمل دوائر متعددة.
2	Field Effect Transistor (FET) Amplifiers in Mid-Band Range.	
3	Operational Amplifier Characteristics.	
4	Operational Amplifier Applications.	
5	Active Filters Based on Operational Amplifiers.	
6	Oscillators.	
7	Timing Circuits using IC 555.	
8	Flip Flops and Counters.	
9	Opto-components.	

رابعاً: الخدمات المجتمعية التي يؤديها المعمل:

- **عدد المستفيدين من المعمل:** جميع طلاب (مرحلة البكالوريوس والماجستير والدكتوراه) للقسم وأقسام الكلية المختلفة وكذلك بعض الكليات الأخرى.

- **الجهات التي تتعاون مع المعمل:** جميع أقسام الكلية وبعض الكليات الأخرى.

- **الدخل السنوي للمعمل:** لا يتم تحصيل أية رسوم.

- **الجهات الممولة لأنشطة المعمل:** إدارة الكلية.

- **المشاريع التنافسية التي يشارك فيها المعمل:** العديد

خامساً: الخدمات الطلابية التي يؤديها المعمل:

- **عدد الطلاب المستفيدين من المعمل:** جميع طلاب (مرحلة البكالوريوس والماجستير والدكتوراه) للقسم وأقسام الكلية المختلفة وكذلك بعض الكليات الأخرى.

- **الأقسام العلمية المستفيدة من المعمل:** جميع أقسام الكلية وبعض الكليات الأخرى.

- **الفرق الدراسية المستفيدة من المعمل:** جميع طلاب (مرحلة البكالوريوس والماجستير والدكتوراه) للقسم وأقسام الكلية المختلفة وكذلك بعض الكليات الأخرى.

- **المقررات الدراسية التي تستفيد من المعمل:** مقررات القسم والأقسام الأخرى.

- **الأنشطة الطلابية داخل المعمل:** سكاشن ومشاريع تخرج ومشاريع تنافسية وأبحاث ماجستير ودكتوراه.

- **عدد طلاب الدراسات العليا المستفيدين من المعمل:** العديد

- **عدد الرسائل العلمية التي تمت في المعمل:** العديد

- **عدد الدورات التدريبية التي تمت في المعمل:** العديد

- **المسابقات العملية التي شارك فيها طلاب من المستفيدين من المعمل:** العديد

التجربة الأولى

Bipolar Junction Transistor (BJT)

.Amplifiers in Mid-Band Range

Experiment Title:

- Bipolar Junction Transistor (BJT) Mid-Band Amplifiers.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-request:

- How to determine BJT terminals (Emitter, Base, and Collector).
- BJT output and input characteristics.
- BJT main functions.
- Different DC-biasing techniques of BJT.
- BJT modes of operation

Part-II: Experiment Procedure

II.1 CE Amplifier

A. Required Components

- An NPN-BJT of type 2N3904.
- One 1 KΩ resistor of 1/2 watt power rating.
- One 4 KΩ resistor of 1/2 watt power rating.

- One 5 KΩ resistor of 1/2 watt power rating.
- One 15 KΩ resistor of 1/2 watt power rating.
- One 3.9 KΩ resistor of 1/2 watt power rating.
- Three 1 μF capacitor of 20 volts rating.

B. Required Devices

- A two channel Oscilloscope.
- Function generator.
- Digital multimeter adjusted to measure the AC current.
- A Dual DC supply.

C. Procedure

- Construct the circuit shown in Fig.13; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 5 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.14.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.
- Compute the voltage gain $A_V = \left|\frac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.15.
- Connect an AC ammeter to measure I_{out}; Fig.15.
- Compute the current gain $A_I = \left|\frac{I_{out}}{I_{in}}\right|$.

- Connect an AC voltmeter to measure V_{in}; Fig.15.
- Compute the input impedance $R_{in} = \left|\frac{V_{in}}{I_{in}}\right|$
- Give your comments.

III.1 CE Amplifier

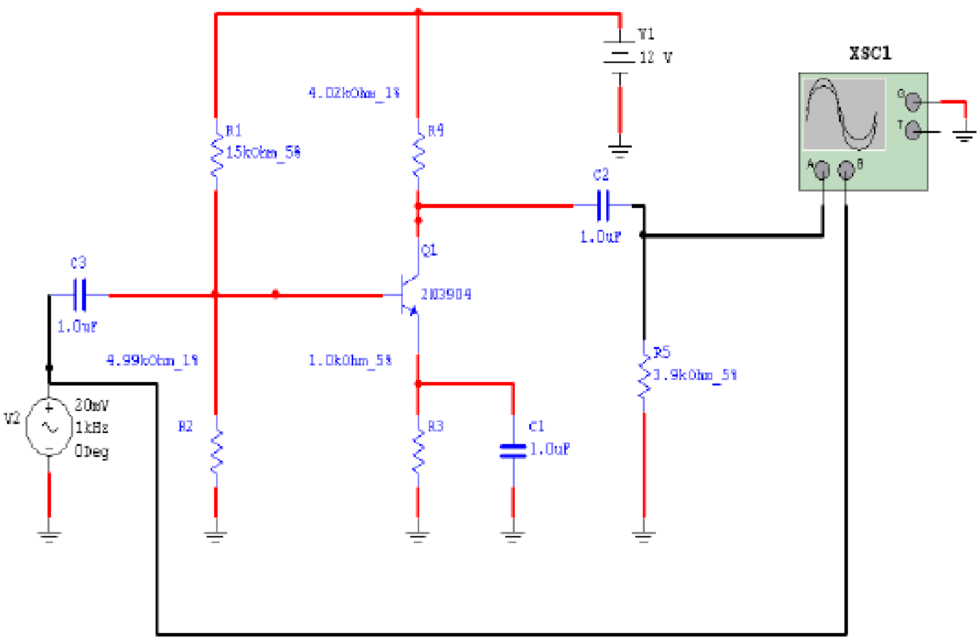


Fig.13 Common Emitter (CE) Amplifier

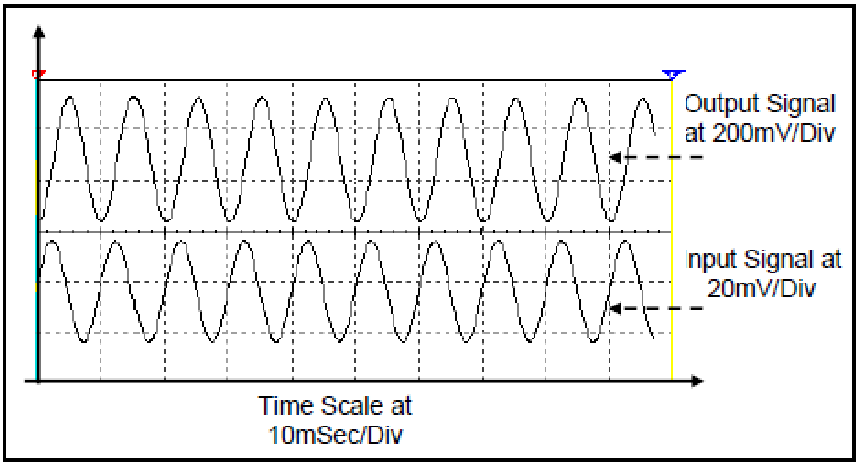


Fig.14 Output and Input Waveforms of a CE Amplifier

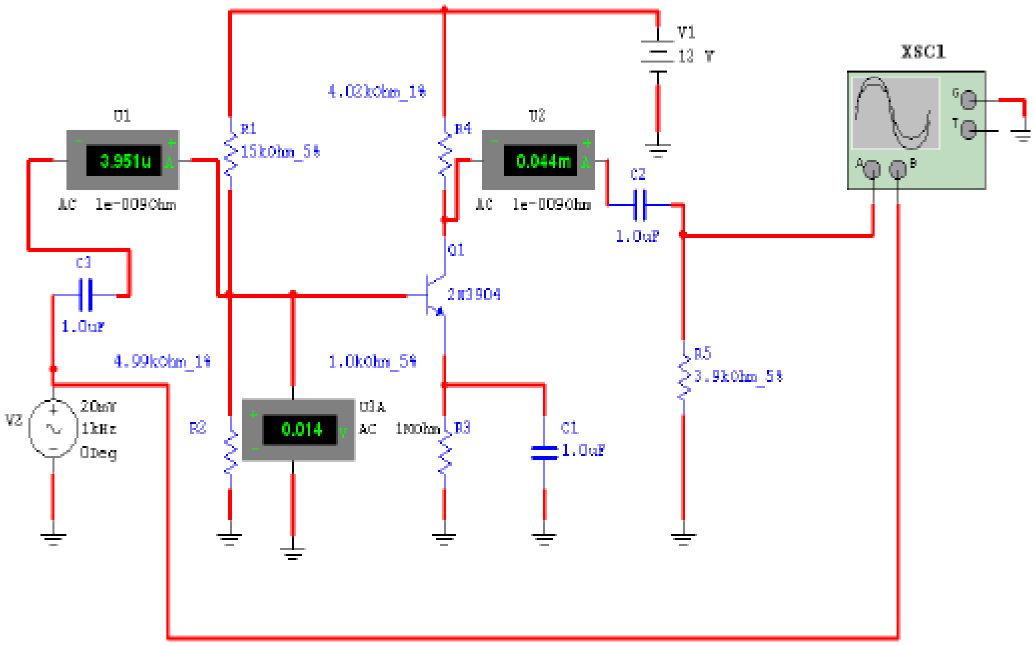


Fig.15 A CE Amplifier Connected to Determine Z_{in} and A_I.

II.2 CC Amplifier

A. Required Components

- An NPN-BJT of type 2N3904.
- One 1 KΩ resistor of 1/2 watt power rating.
- One 4 KΩ resistor of 1/2 watt power rating.
- One 5 KΩ resistor of 1/2 watt power rating.
- One 15 KΩ resistor of 1/2 watt power rating.
- One 3.9 KΩ resistor of 1/2 watt power rating.
- Three 1 μF capacitor of 20 volts rating.

B. Required Devices

- A two channel Oscilloscope.
- Function generator.

- Digital multimeter adjusted to measure the AC current.
- A Dual DC supply.

C. Procedure

- Construct the circuit shown in Fig.16; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 5 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.17.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.
- Compute the voltage gain $A_V = \left|\frac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.18.
- Connect an AC ammeter to measure I_{out}; Fig.18.
- Compute the current gain $A_I = \left|\frac{I_{out}}{I_{in}}\right|$.
- Connect an AC voltmeter to measure V_{in}; Fig.18.
- Compute the input impedance $R_{in} = \left|\frac{V_{in}}{I_{in}}\right|$
- Give your comments.

III.2 CC Amplifier

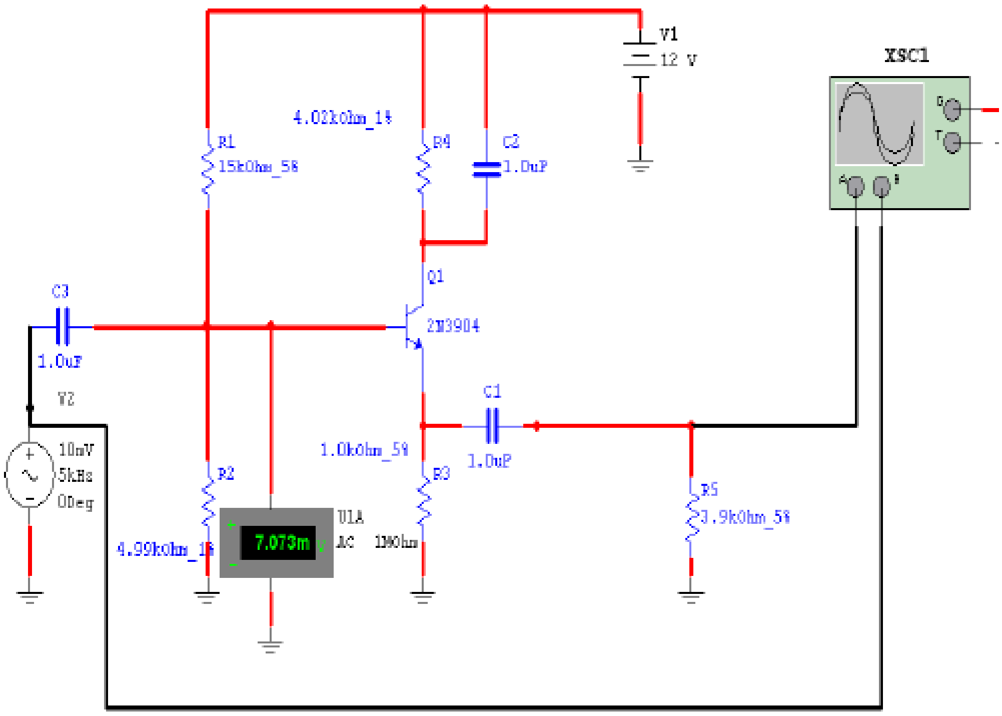


Fig.16 Common Collector (CC) Amplifier

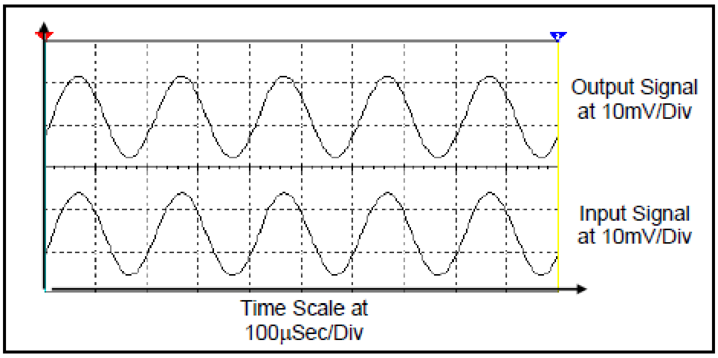


Fig.17 The output and input waveforms of a CC amplifier

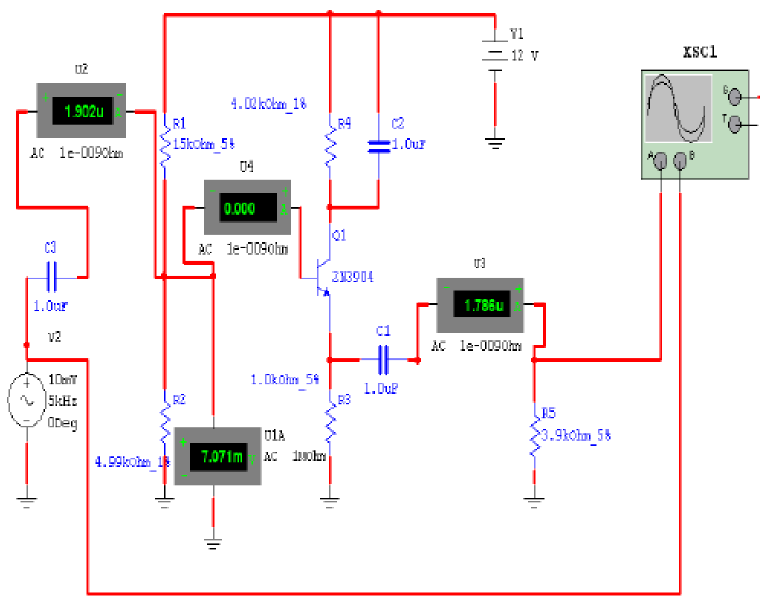


Fig.18 A CC amplifier connected to determine Z_{in} and A_I

III.3 CB Amplifier

A. Required Components

- An NPN-BJT of type 2N3904.
- One 10 KΩ resistor of 1/2 watt power rating.
- One 100 Ω resistor of 1/2 watt power rating.
- One 3.9 KΩ resistor of 1/2 watt power rating.

- One 15 KΩ resistor of 1/2 watt power rating.
- Two 1 μF capacitor of 20 volts rating.

B. Required Devices

- A two channel Oscilloscope.
- Function generator.
- Digital multimeter adjusted to measure the AC current.
- A Dual DC supply.

C. Procedure

- Construct the circuit shown in Fig.19; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 5 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.20.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.
- Compute the voltage gain $A_V = \left|\frac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.21.
- Connect an AC ammeter to measure I_{out}; Fig.21.
- Compute the current gain $A_I = \left|\frac{I_{out}}{I_{in}}\right|$.
- Connect an AC voltmeter to measure V_{in}; Fig.21.

- Compute the input impedance $R_{in} = \left|\frac{V_{in}}{I_{in}}\right|$

- Give your comments.

III.3 CB Amplifier

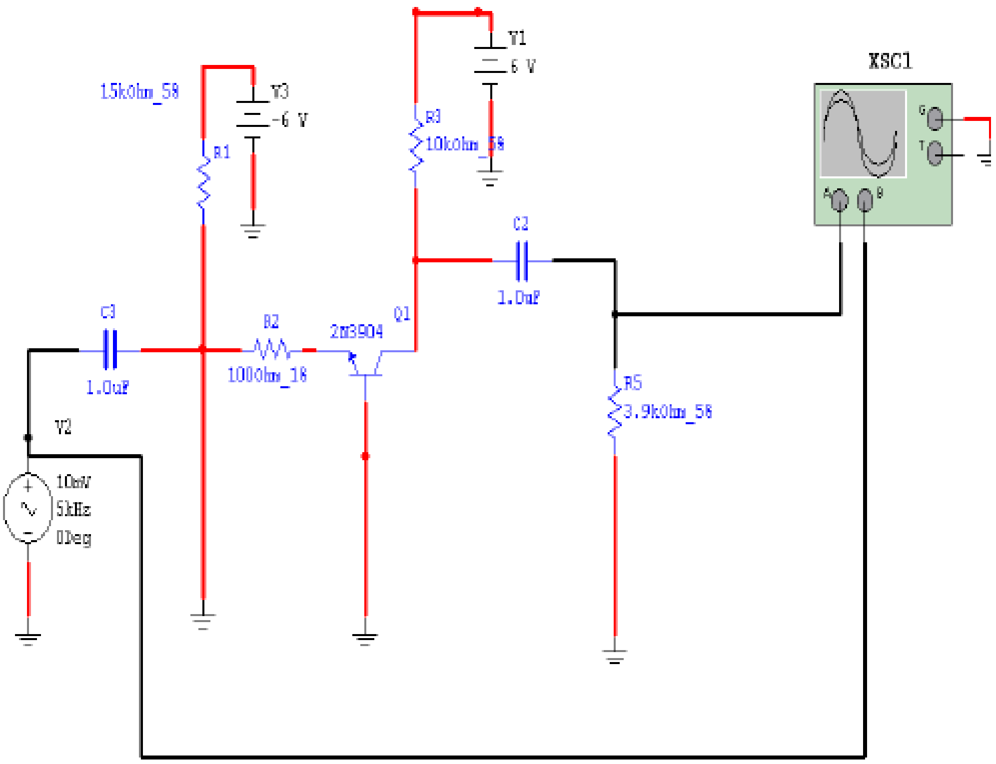


Fig.16 CB amplifier

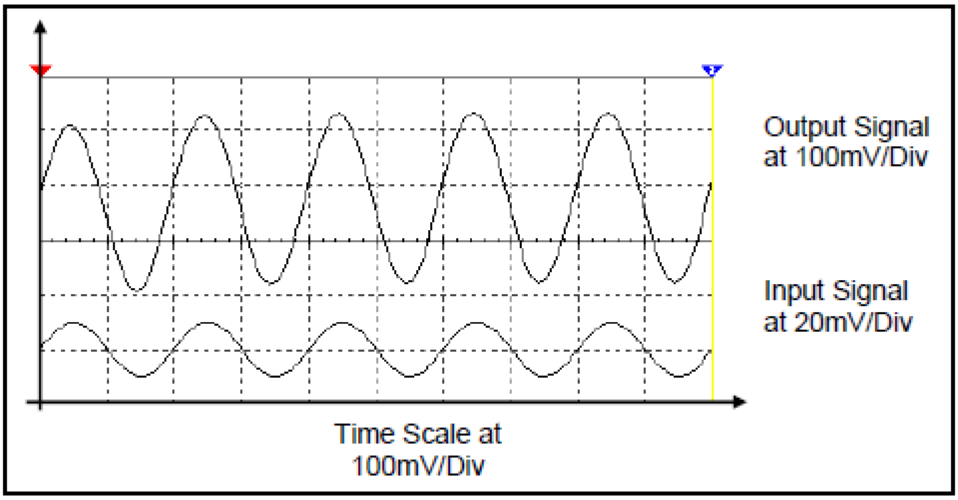


Fig.20 The output and input waveforms of a CB amplifier

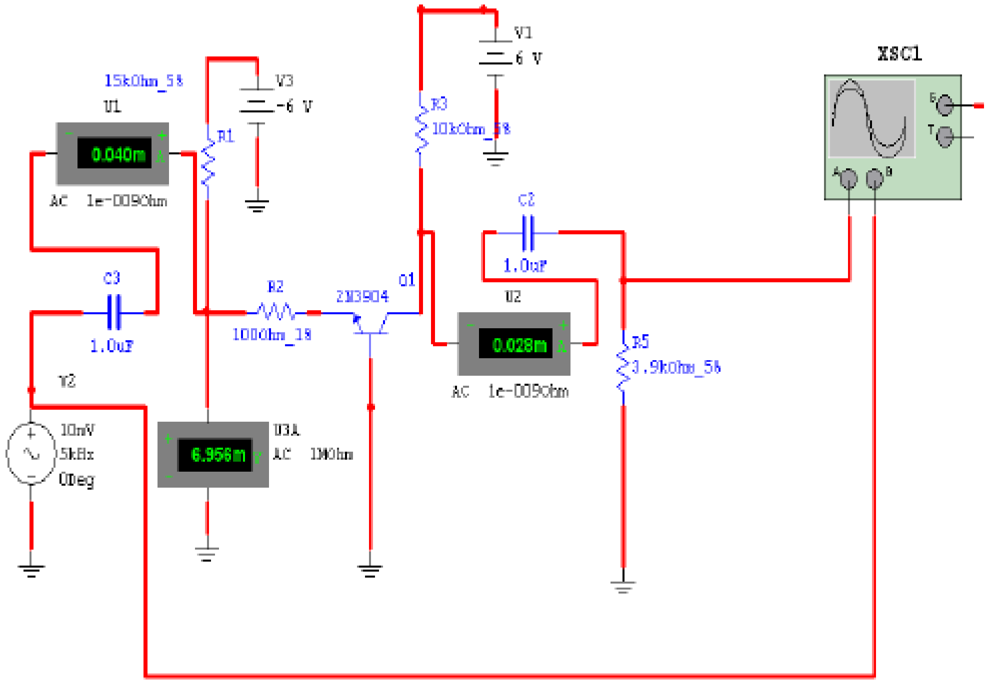


Fig.21 A CB amplifier connected to determine Z_{in} and A_I.

التجربة الثانية

Field Effect Transistor (FET) Amplifiers .in Mid-Band Range

Experiment Title:

- Field Effect Transistor (FET) Amplifiers in Mid-Band Range

Objectives:

- To determine the input and output characteristics of FET transistor.
- To compare the performance of FET amplifier configurations.
- To implement FET amplifier operating in mid-band range.
- To compare between small and large signal models.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

II.3 JFET Transistor Amplifiers

A. CS Amplifier

A.1 Required Components

- An N-Channel JFET of type 2N5545.
- Two 2 KΩ resistors of 1/2 watt power rating.
- One 3.9 KΩ resistor of 1/2 watt power rating.
- One 100 KΩ resistor of 1/2 watt power rating.

- One 200 KΩ resistor of 1/2 watt power rating.
- Three capacitors of 20 volts rating of values 0.1 μF, 1 μF and 10 μF.

A.2 Required Devices

- A two channel Oscilloscope.
- Function generator.
- Digital multimeter adjusted to measure the AC current and voltage.
- A Dual DC supply.

A.3 Procedure

- Construct the circuit shown in Fig.9; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 1 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.10.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.
- Compute the voltage gain $A_V = \left|\frac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.11.
- Connect an AC voltmeter to measure V_{in}; Fig.11.
- Compute the input impedance $R_{in} = \left|\frac{V_{in}}{I_{in}}\right|$
- Give your comments.

Part-III: Computer Simulation

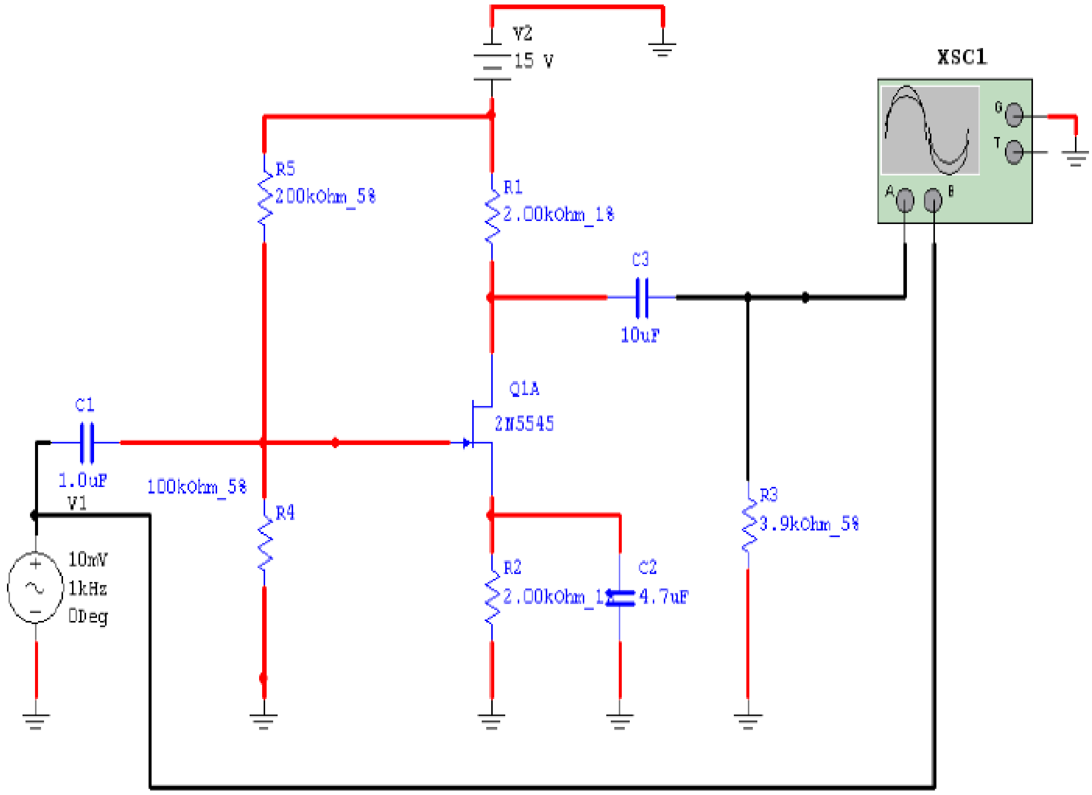


Fig.9 CS-JFET amplifier

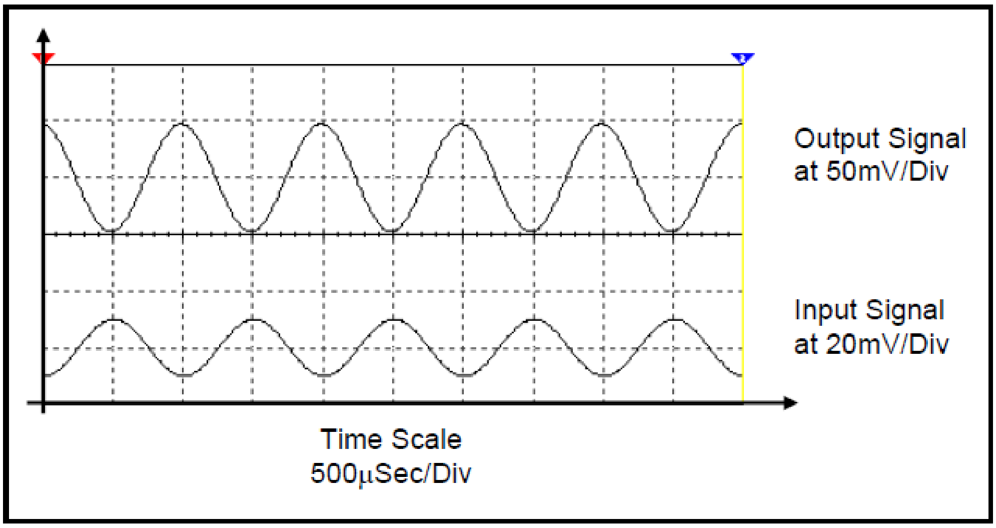


Fig.10 Input and output signals of CS amplifier

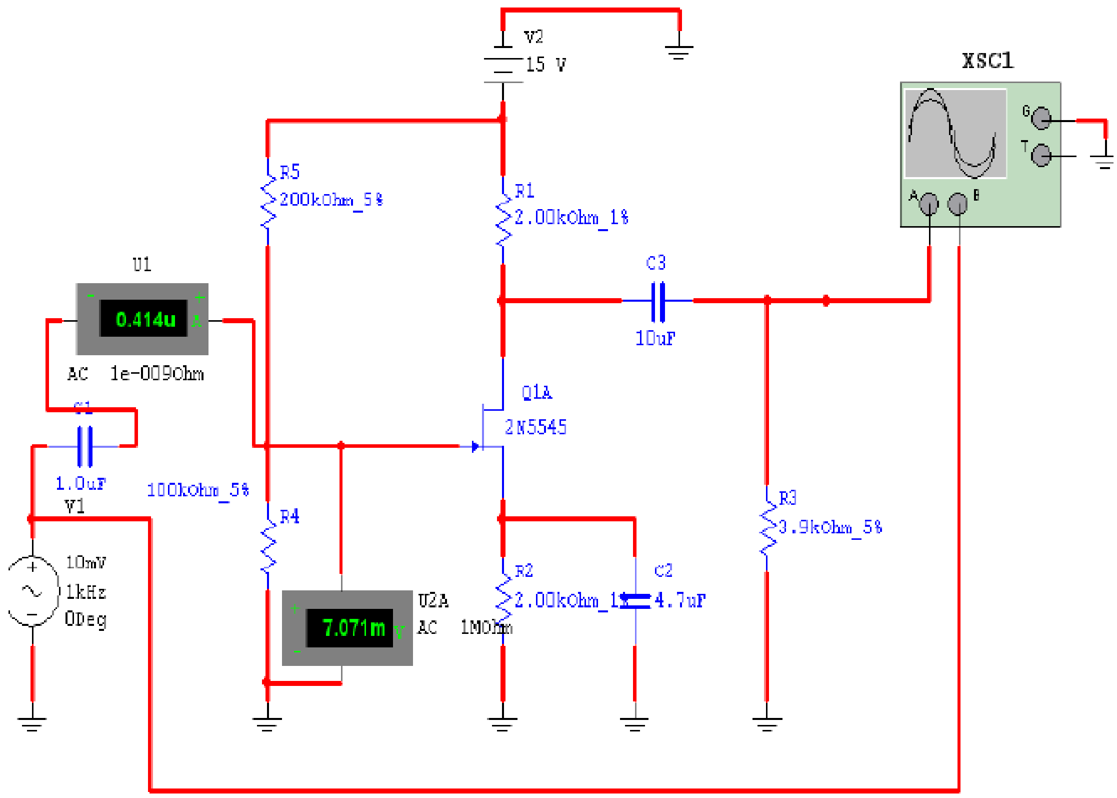


Fig.11 CS amplifier connected to measure Z_{in}

B. CD Amplifier

B.1 Required Components

- An N-Channel JFET of type 2N5545.
- Two 10 KΩ resistors of 1/2 watt power rating.
- One 2 KΩ resistor of 1/2 watt power rating.
- One 1.0 MΩ resistor of 1/2 watt power rating.
- Three capacitors of 20 volts rating of values 0.1 µF, 1 µF and 4.7 µF.

B.2 Required Devices

- A two channel Oscilloscope.
- Function generator.

- Digital multimeter adjusted to measure the AC current and voltage.
- A Dual DC supply.

B.3 Procedure

- Construct the circuit shown in Fig.12; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 1 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.13.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.
- Compute the voltage gain $A_V = \left|\frac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.4.
- Connect an AC voltmeter to measure V_{in}; Fig.14.
- Compute the input impedance $R_{in} = \left|\frac{V_{in}}{I_{in}}\right|$
- Give your comments.

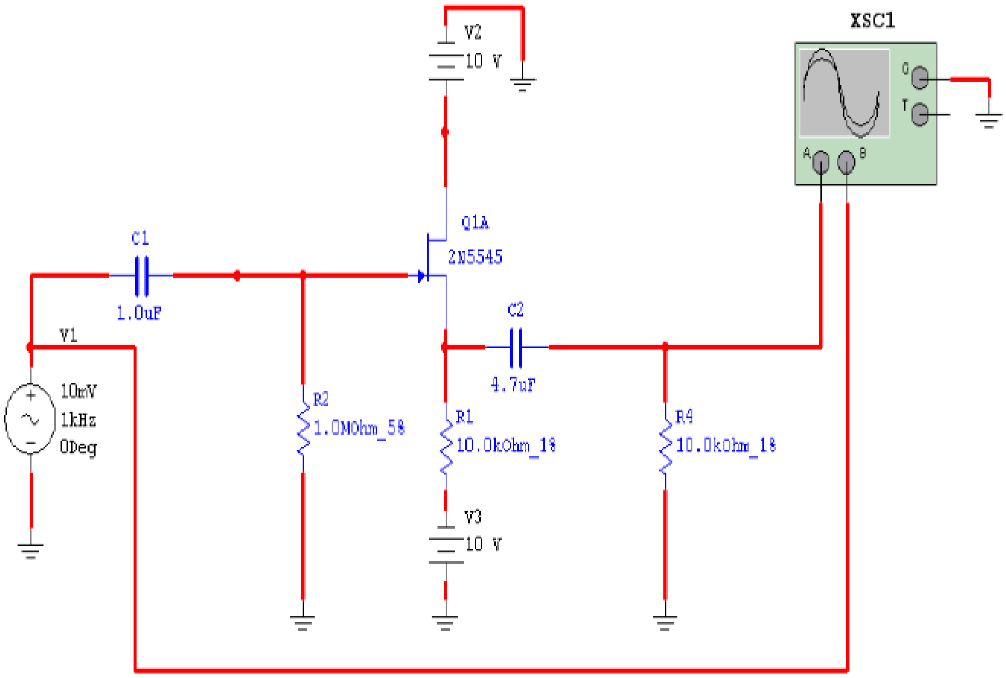


Fig.12 CD JFET amplifier

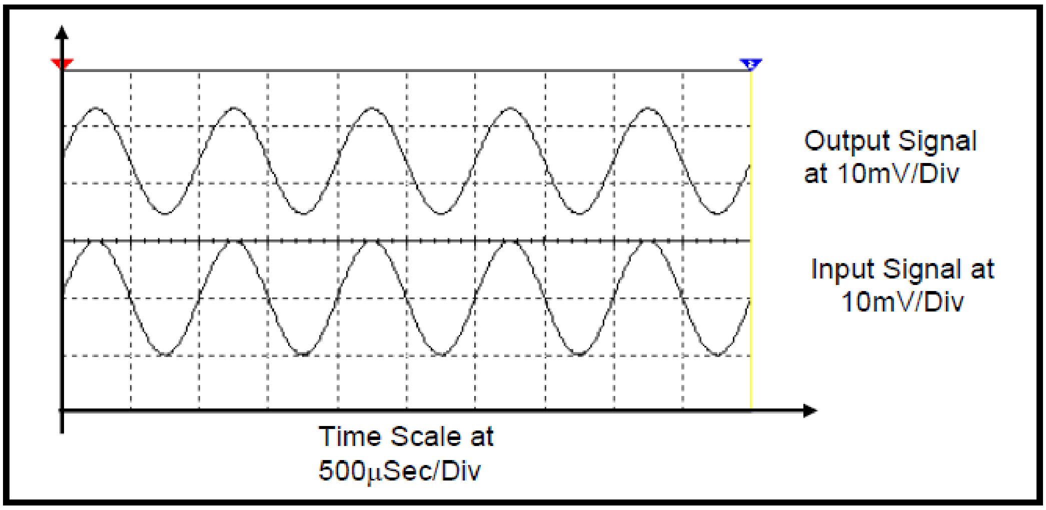


Fig.13 Input and output signals of CD amplifier

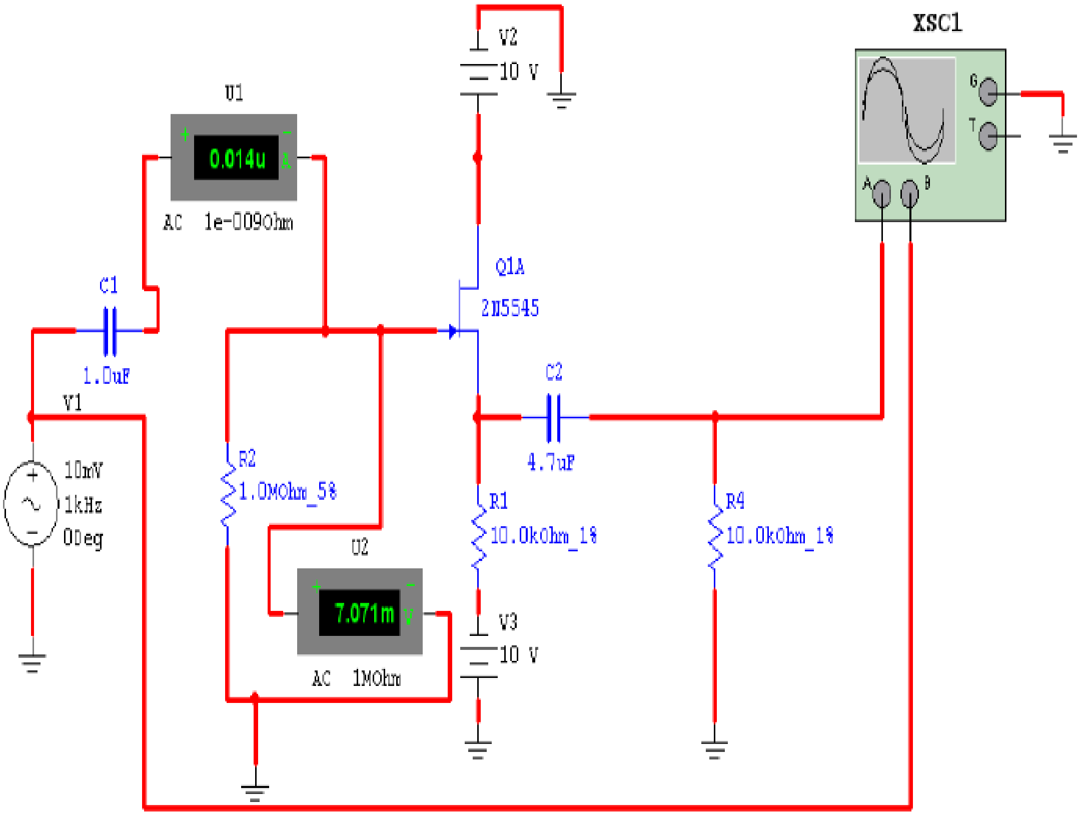


Fig.14 CD amplifier connected to measure Z_{in}

C. CG Amplifier

C.1 Required Components

- An N-Channel JFET of type 2N5545.
- One 10 KΩ resistors of 1/2 watt power rating.
- One 1 KΩ resistor of 1/2 watt power rating.
- One 1.0 MΩ resistor of 1/2 watt power rating.
- One 510 Ω resistor of 1/2 watt power rating.
- Three capacitors of 20 volts rating of values 1 μF, 4.7 μF and 10 μF.

C.2 Required Devices

- A two channel Oscilloscope.
- Function generator.
- Digital multimeter adjusted to measure the AC current and voltage.
- A Dual DC supply.

C.3 Procedure

- Construct the circuit shown in Fig.15; with the above presented components.
- Adjust the function generator to provide a sinusoidal waveform of 10 milli-volts peak value and 1 kHz frequency.
- Connect Ch.A of the Oscilloscope to the display the output voltage and Ch.B to display the input voltage.
- Adjust the VOLT/DIV for Ch.A and Ch.B, hence adjust the TIME/DIV of the oscilloscope; Fig.16.
- Read the peak-to-peak output voltage.
- Read the peak-to-peak input voltage.

- Compute the voltage gain $A_V = \left|\dfrac{V_{out}}{V_{in}}\right|$.
- Connect an AC ammeter to measure I_{in}; Fig.17.
- Connect an AC voltmeter to measure V_{in}; Fig.17.
- Compute the input impedance $R_{in} = \left|\dfrac{V_{in}}{I_{in}}\right|$
- Give your comments.

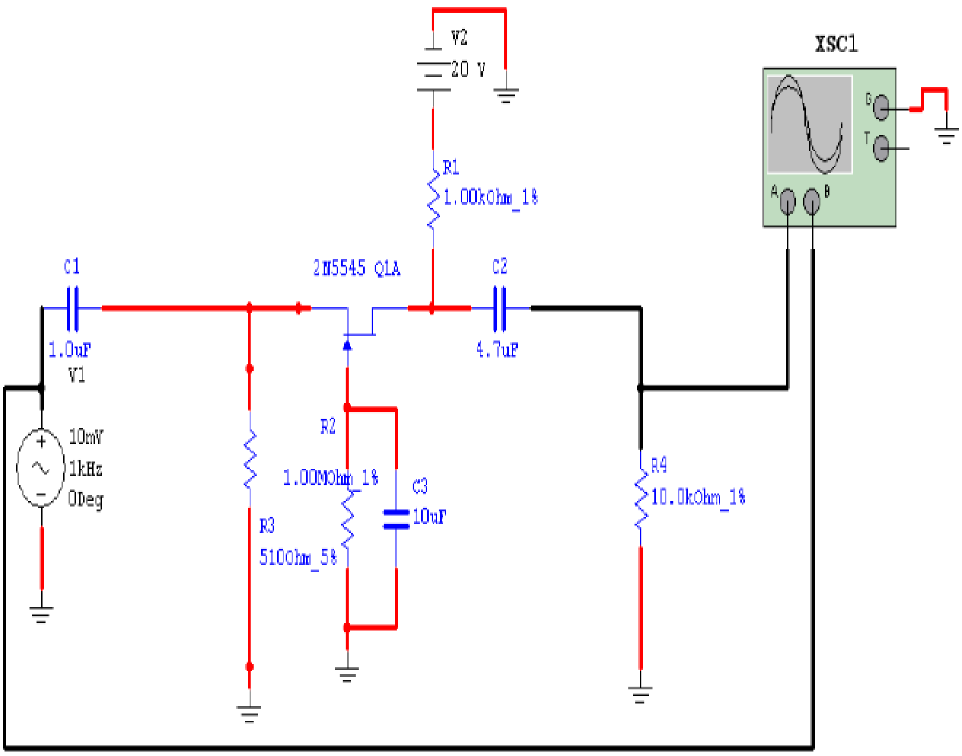
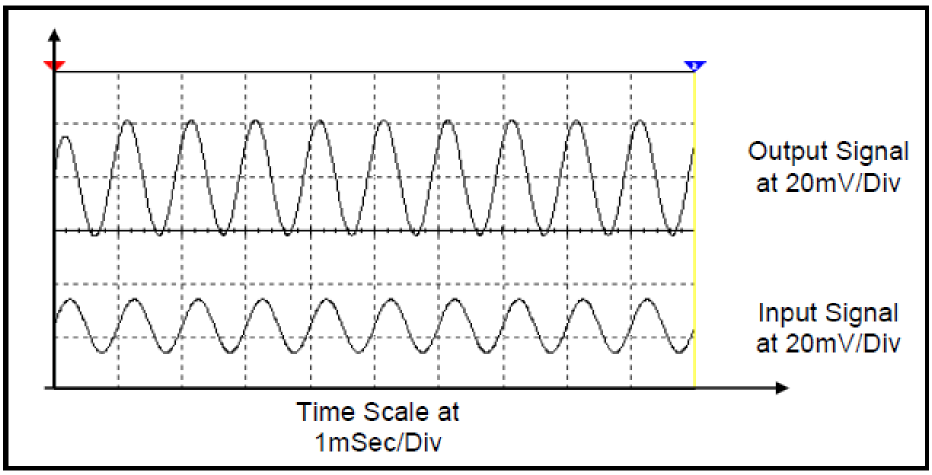


Fig.15 CG JFET amplifier



- *Fig.16 Input and output signals of CG amplifier*

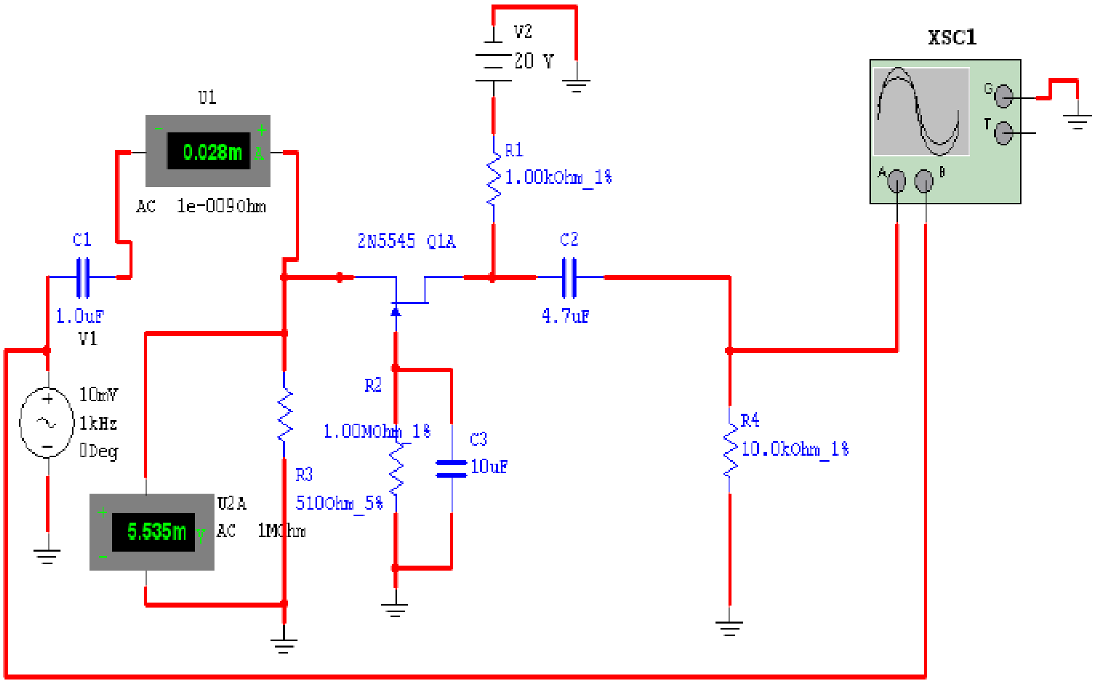


Fig.17 CG amplifier connected to measure Z_{in}

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التجربة الثالثة

Operational Amplifier Characteristics.

Experiment Title:

- Operational Amplifier Characteristics.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Active and passive components.
- Controlled sources.

Part-II: Experiment Procedure

II.1 Open-Loop Gain

A. Required Components

- One μA741 op-amp.
- One 560 Ω resistor of 1/2 watt power rating.
- One 10 KΩ resistor of 1/2 watt power rating.

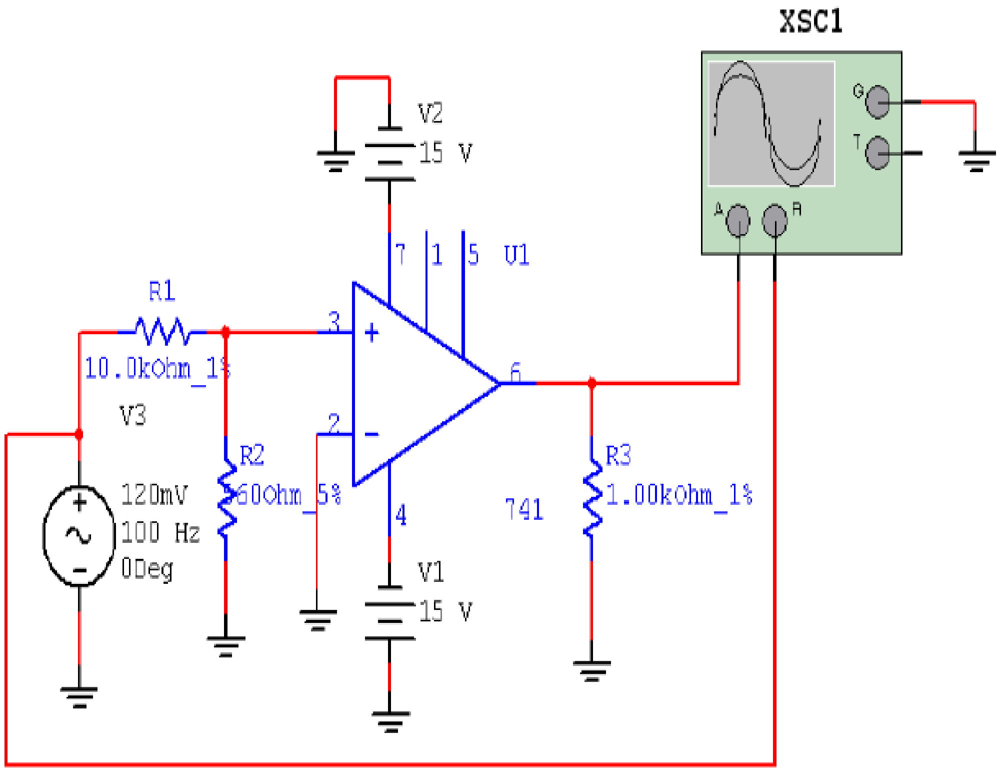
B. Required Devices

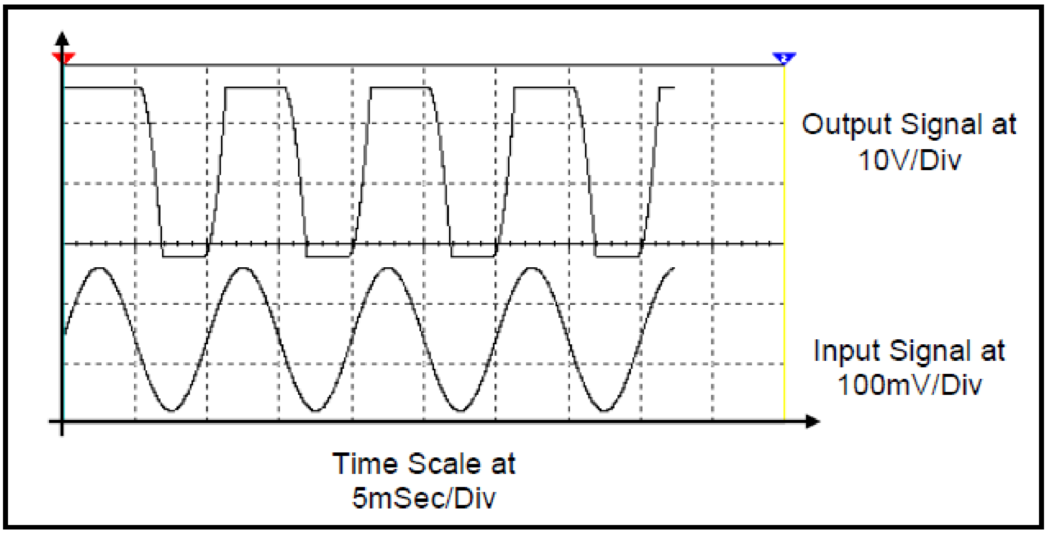
- Dual Dc power supply providing ±15 volts.
- Accurate digital multimeter.

C. Procedure

- Place the chip on the test board and use the dual power supply to apply ±15V to the power pins; Fig.7.
- Using the signal generator attempt to apply a very small 100 Hz sinusoidal signal to the non-inverting input and measure the output amplitude.
- The magnitude of the needed input is very small and can be calculated.
- You may need to feed the chip through a voltage divider in order to get a small enough input signal. Connect signal generator to a series circuit consisting of 10k resistor and 560 ohm, and use the voltage on 560 ohms to drive the op-amp.
- Measure the amplitude of the input and output waveforms. Calculate the gain if possible.
- Repeat the experiment for the inverting input.

III.1 Open Loop Gain





II.2 Input Offset Current

A. Required Components

- One μA741 op-amp.
- Two 220 KΩ resistor of 1/2 watt power rating.
- Two 100 KΩ resistor of 1/2 watt power rating.
- Two 100 Ω resistor of 1/2 watt power rating.

B. Required Devices

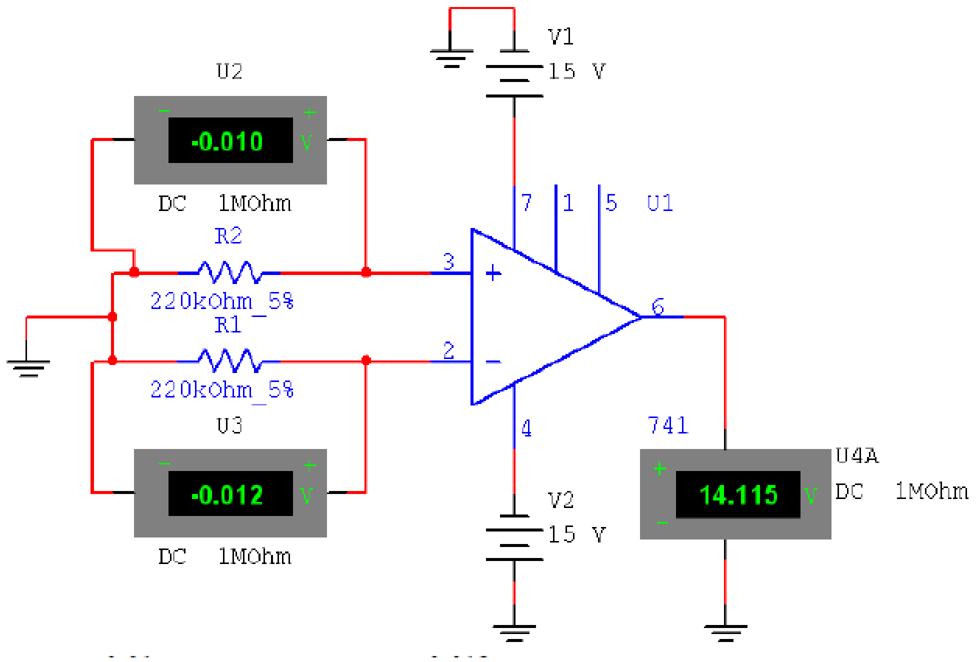
- Dual Dc power supply providing ±15 volts.
- Accurate digital multimeter.

C. Procedure

- Connect the circuit in Fig.8 and apply the ±15V power.
- Then, measure the voltages across the two 220k resistors.
- Use ohms law to calculate the respective currents. Label these currents I_{B+} for the resistor connected to the non-inverting input and I_{B-} for the resistor connected to the inverting input.
- Find the input offset current from the previous data: $I_{io} = I_{B+} - I_{B-}$.
- Repeat the above procedure with 100k and with 100 Ω resistors.
- Report your results in Table.2.

Table.2 The input offset current			
Input Resistance	I_{B+}	I_{B-}	I_{io}
220 KΩ			
100 KΩ			
100 Ω			

III.2 Input Offset Current



II.3 Input and Output Offset Voltage

A. Required Components

- One µA741 op-amp.
- Two 100 Ω resistors or 1/2 watt power rating.
- One 100 KΩ resistors or 1/2 watt power rating.
- One 220 KΩ resistors or 1/2 watt power rating.
- One 1.0 KΩ resistors or 1/2 watt power rating.

B. Required Devices

- Dual Dc power supply providing ±15 volts.
- Accurate digital multimeter.

C. Procedure

- Connect the circuit in Fig.9. Make sure that you have powered the chip with the dual power supply (±15V). This is called an inverting operational amplifier circuit. For this test, the input to the amp is grounded.
- Measure the output voltage. This is the output offset voltage; V_{oo}.
- The input offset voltage of the amplifier can be calculated by dividing the output offset voltage by the closed loop voltage gain:

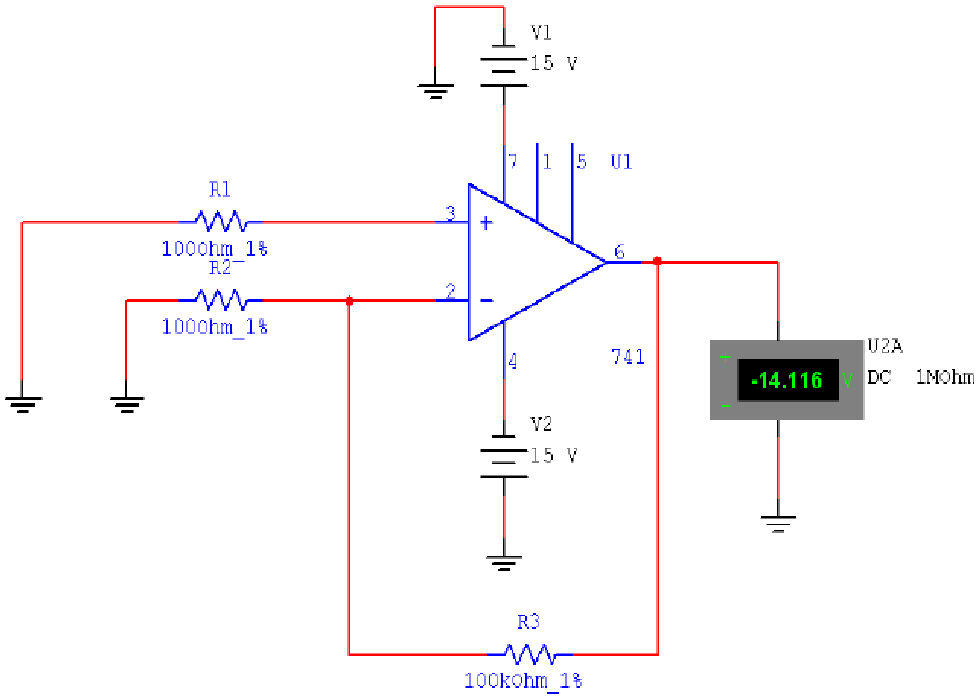
$$V_{io} = \frac{V_{oo}}{A}.$$

- Replace the 100kΩ resistor with 220kΩ and 1 KΩ resistors and repeat the above procedure.
- Report your results in Table.3.

Table.3 The input and output offset voltages			
Feedback Resistance	V_{oo}	$A=R_F/100$	$V_{io}=V_{oo}/A$
100 KΩ			
220 KΩ			
1 KΩ			

-

III.3 Input and Output Offset Voltages



II.5 Slew Rate

A. Required Components

- One μA741 op-amp.
- One 10kΩ resistor of 1/2 watt power rating.

B. Required Devices

- Dual Dc power supply providing ±15 volts.
- Two channel oscilloscope.
- Function generator.

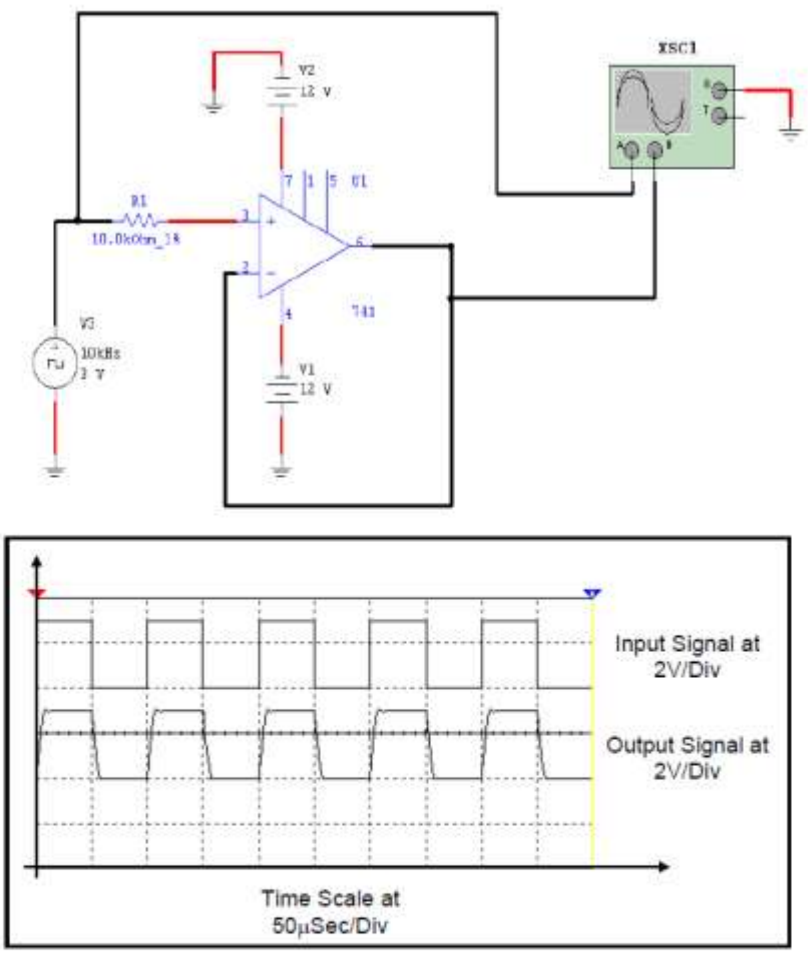
C. Procedure

- Connect the circuit shown in Fig.11.
- Adjust the function generator to provide a square signal of amplitude 6-V peak-to-peak.
- Connect Ch.A of the oscilloscope to display the input square wave, and Ch.B to display the resulting output signal.
- Measure the slope of the output waveform, during transition between the two peak levels (upper and lower):

$$SR = \max imum\left(\frac{dV_o}{dt}\right)$$

- Repeat this procedure with different input frequencies until the output will be seen attenuated.

II.4 Slew rate



التجربة الرابعة

.Operational Amplifier Applications

Experiment Title:

- Operational Amplifier Applications.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Op-amp characteristics.
- Op-amp ideal features.
- The node voltage method and K.C.L.
- Op-amp datasheets.

II.1 Inverting Amplifier

A. Required Components

- One μA741 op-amp.
- One 2 KΩ and one 4 KΩ resistor of 1/2 watt power rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.10.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 100 mV and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

II.1 Inverting Amplifier

A. Required Components

- One μA741 op-amp.
- One 2 KΩ and one 4 KΩ resistor of 1/2 watt power rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.10.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 100 mV and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

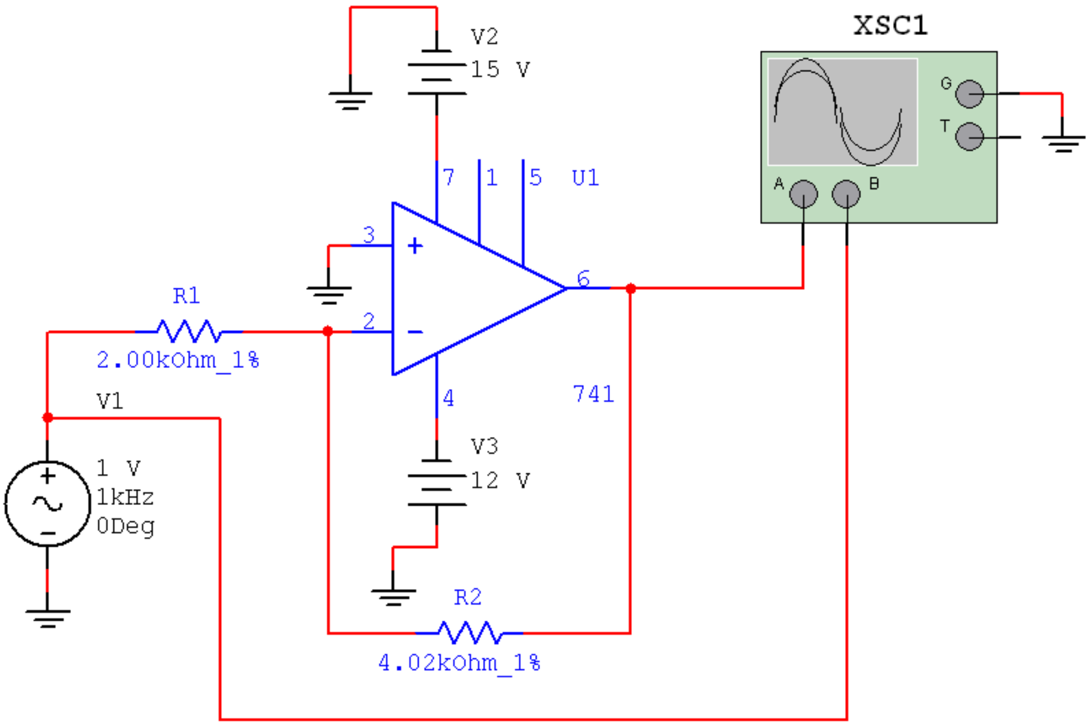


Fig.10 Inverting Operational Amplifier

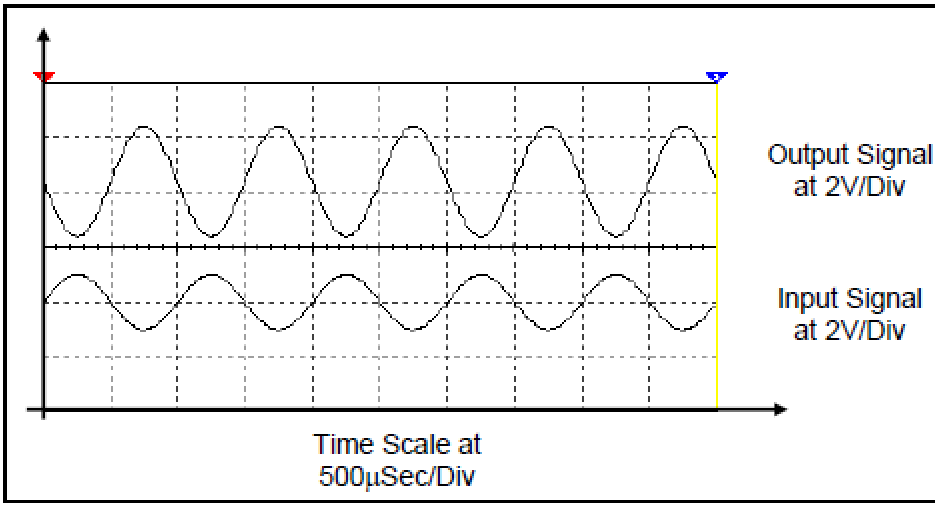


Fig.11 input and output waveforms of inverting amplifier

II.2 Non-Inverting Amplifier

A. Required Components

- One μA741 op-amp.
- One 2 KΩ resistor of 1/2 watt power rating.
- One 4 KΩ resistor of 1/2 watt power rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.12.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 100 mV and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

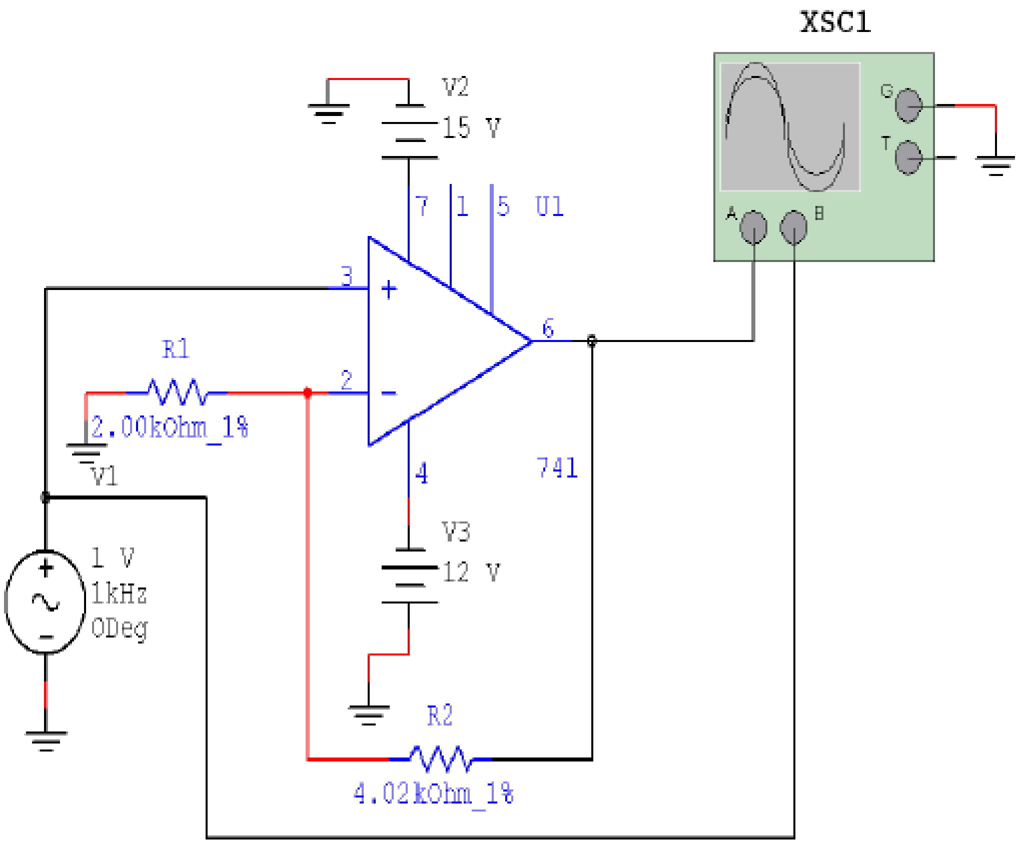


Fig.12 Non-Inverting Operational Amplifier

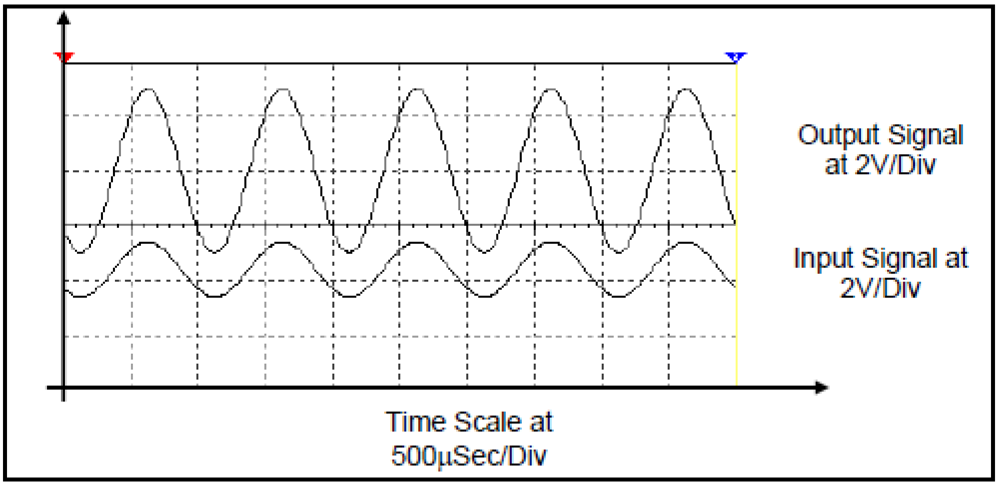


Fig.13 input and output waveforms of a non-inverting amplifier

II.3 Voltage Follower

A. Required Components

- One μA741 op-amp.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.14.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 1.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

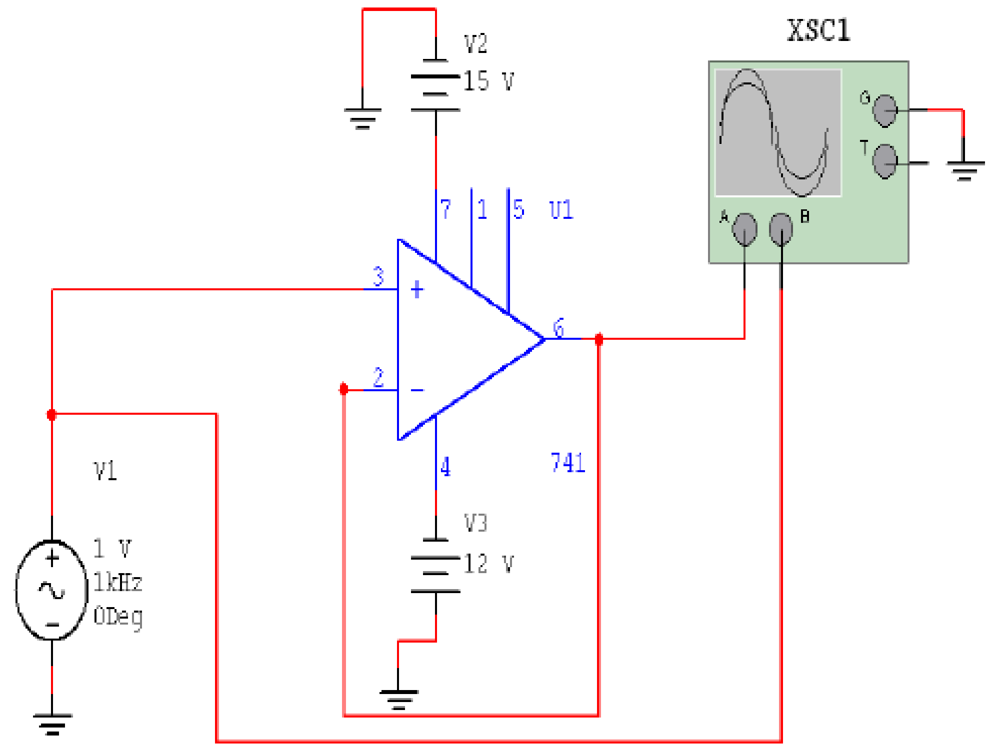


Fig.14 Buffer Operational Amplifier

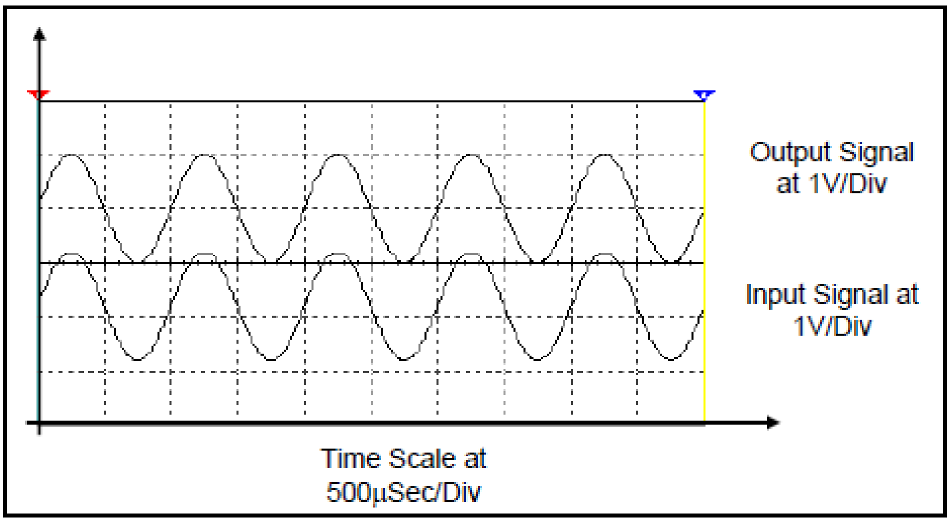


Fig.15 input and output signals of a voltage follower op-amp

II.4 Summing Amplifier

A. Required Components

- One μA741 op-amp.
- One 2 KΩ resistor of 1/2 watt power rating.
- One 4 KΩ resistor of 1/2 watt power rating.
- One 8 KΩ resistor of 1/2 watt power rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.
- 3 volts battery of C-size.

C. Procedure

- Construct the circuit shown in Fig.16.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 1.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

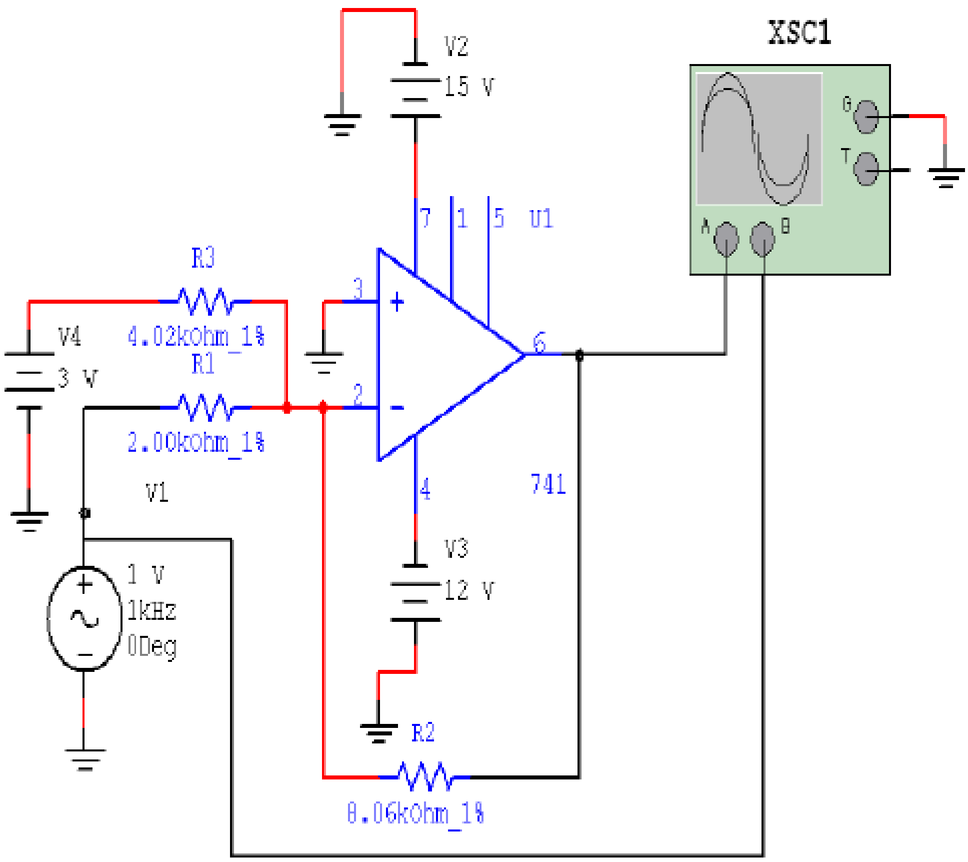


Fig.16 Summing Operational Amplifier

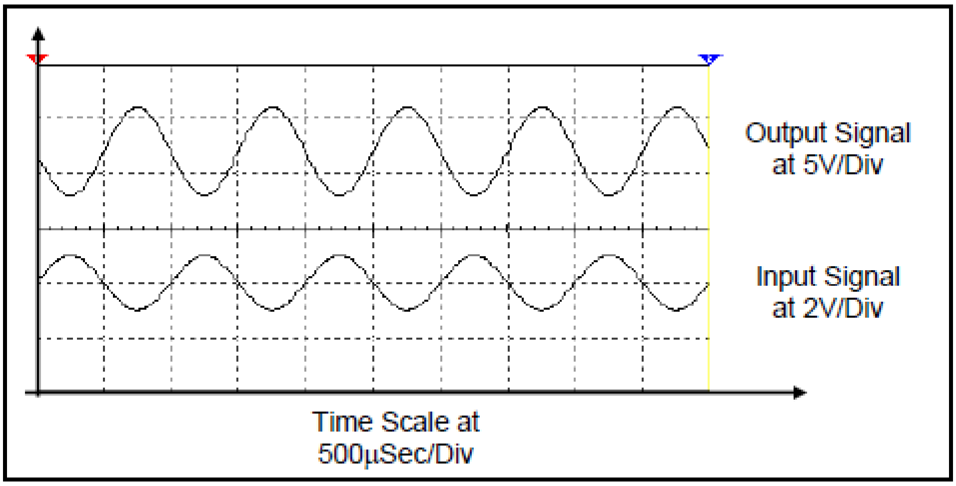


Fig.17 input and output waveforms of summing amplifier

II.5 Differential Amplifier

A. Required Components

- One μA741 op-amp.
- Two 2 KΩ resistors of 1/2 watt power rating.
- Two 4 KΩ resistors of 1/2 watt power rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.
- 3 volts battery of C-size.

C. Procedure

- Construct the circuit shown in Fig.18.
- Adjust the function generator to provide a sinusoidal wave form of peak voltage of 1.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.

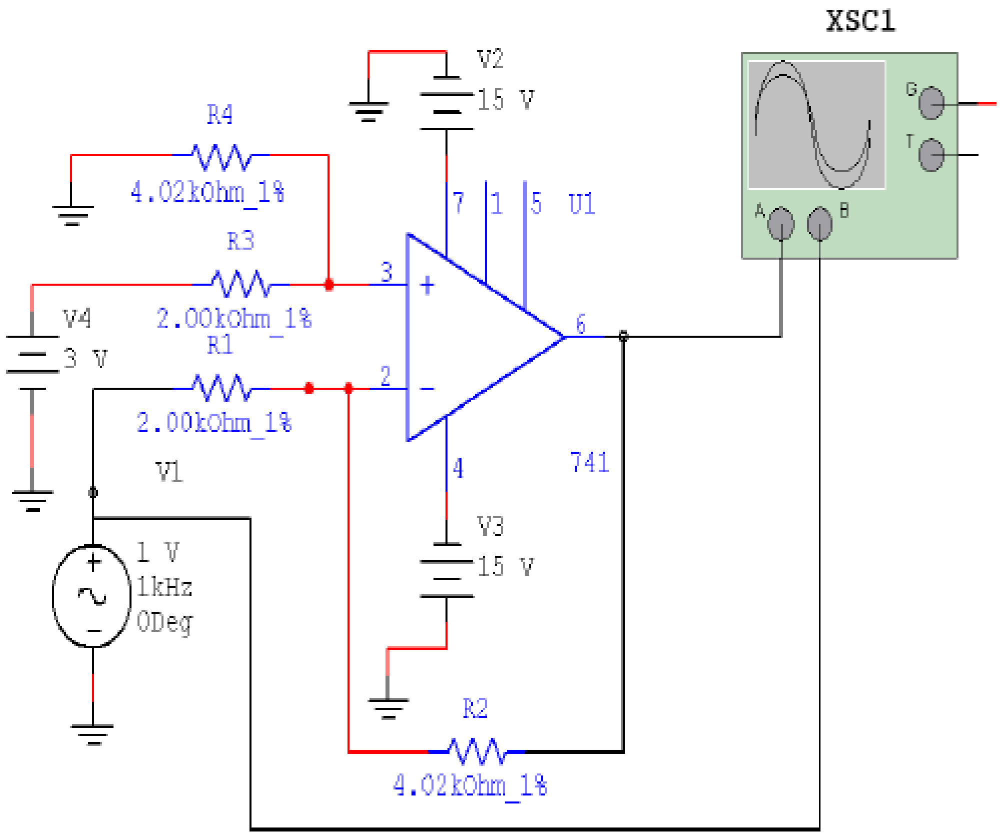


Fig.18Differential Operational Amplifier

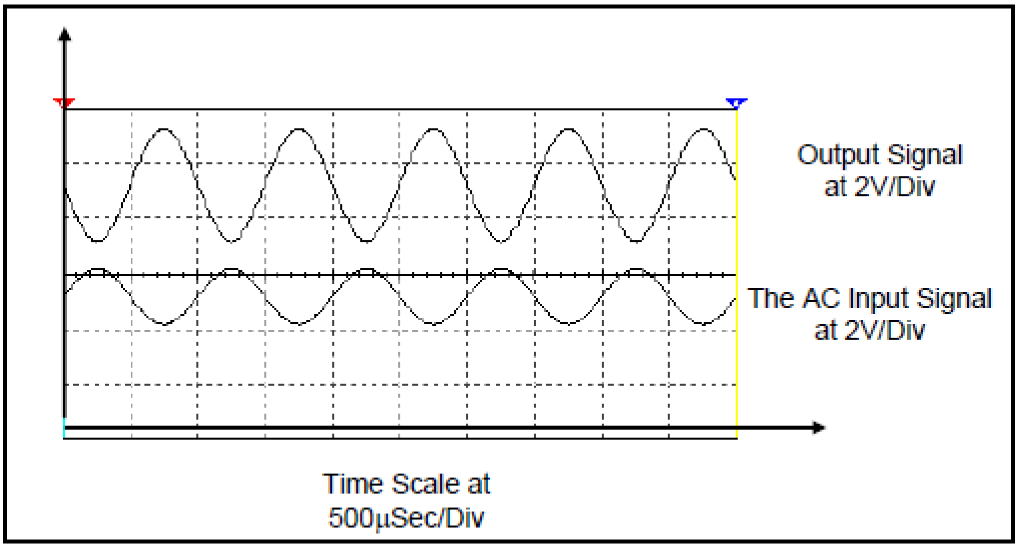


Fig.19 input and output waveforms of differential amplifier

II.6 Inverting Integrator

A. Required Components

- One μA741 op-amp.
- Two 10 KΩ resistors of 1/2 watt power rating.
- One 100 KΩ resistors of 1/2 watt power rating.
- One 10 nF capacitor of 20 volts rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.20.
- Adjust the function generator to provide a square wave of peak voltage of 1.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.
- Repeat with other frequencies of 100 Hz, 10 KHz, and 1 MHz.

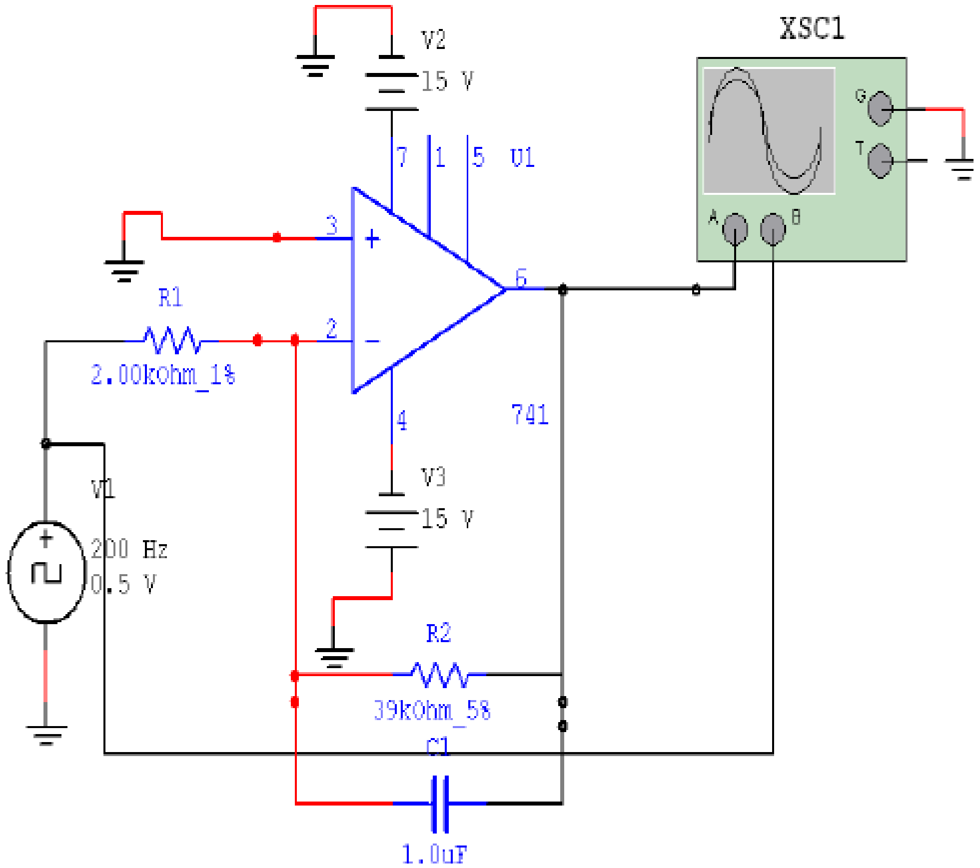


Fig.20 Integrating Operational Amplifier

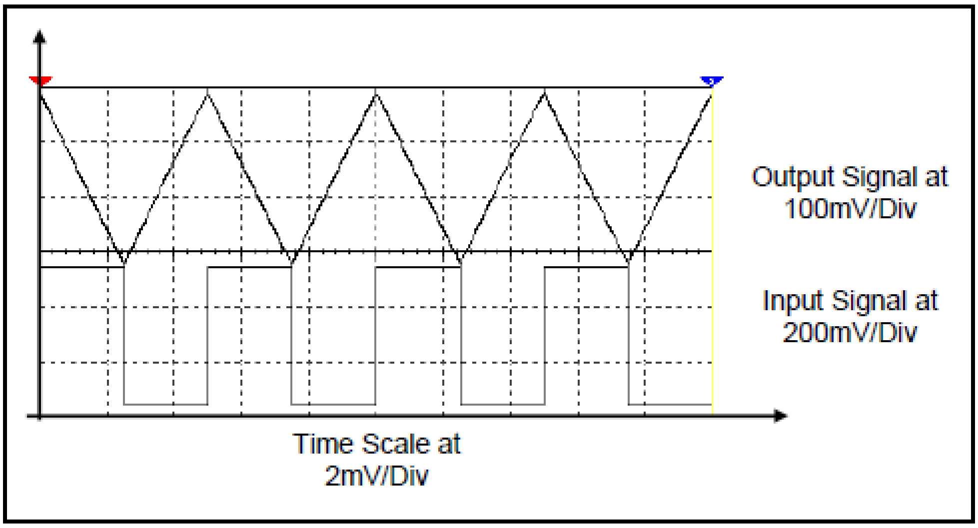


Fig.21 Output and Input Waveforms of Integrating Op-amp

II.7 Inverting Differentiator

A. Required Components

- One μA741 op-amp.
- Two 10 KΩ resistors of 1/2 watt power rating.
- One 10 nF capacitor of 20 volts rating.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.22.
- Adjust the function generator to provide a square wave of peak voltage of 1.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.
- Repeat with other frequencies of 100 Hz, 10 KHz, and 1 MHz.

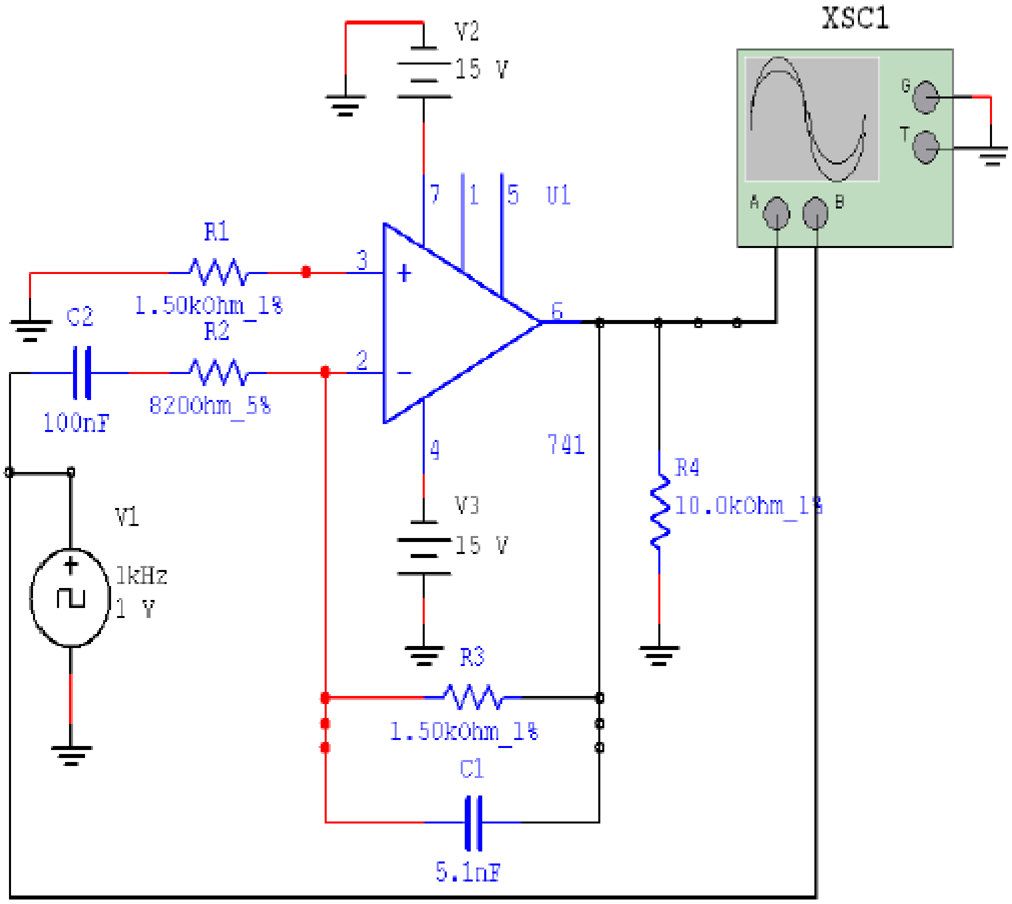


Fig.22 Differentiator-Based Operational Amplifier

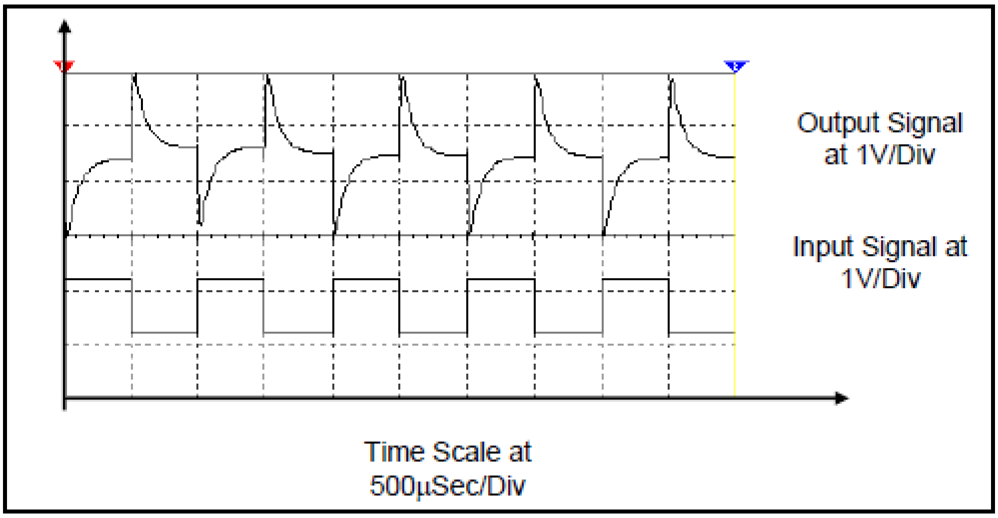


Fig.23 Output and Input Waveforms of Differentiator Op-amp

II.8 Precision Rectifier

A. Required Components

- One μA741 op-amp.
- One 10 KΩ resistors of 1/2 watt power rating.
- One 1N4009 diode.

B. Required Devices

- Two channel Oscilloscope.
- Dual DC power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.24.
- Adjust the function generator to provide a square wave of peak voltage of 2.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.
- Repeat with other frequencies of 100 Hz, 10 KHz, and 1 MHz.

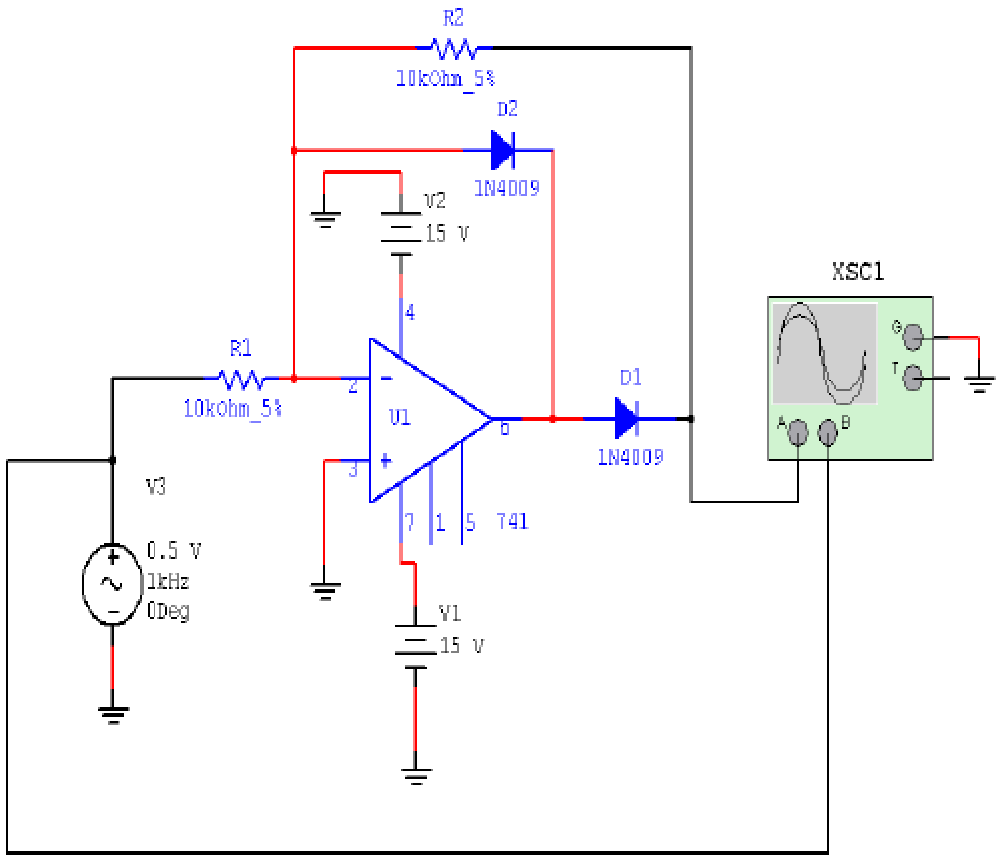


Fig.24 Precision Half Wave Rectifier

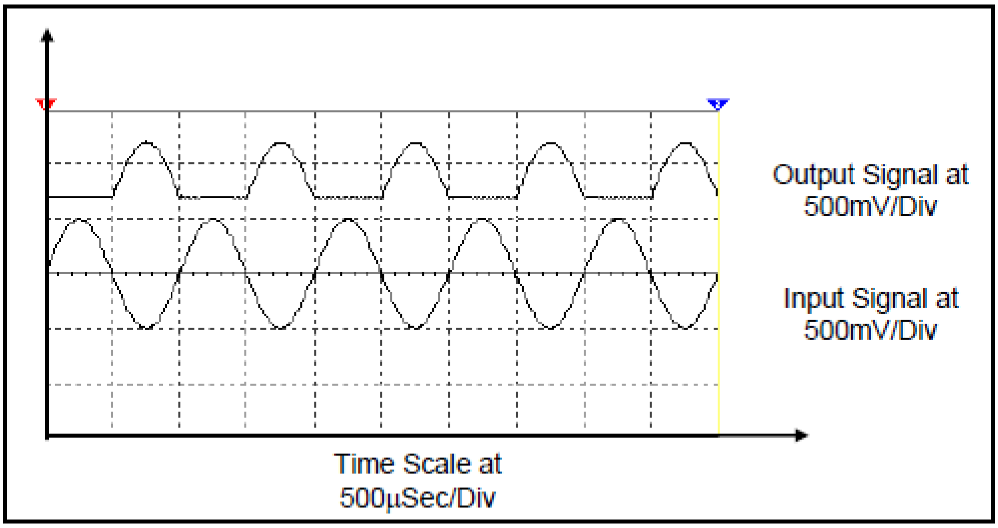


Fig.25 input and output signals of a precision rectifier op-amp

II.9 Comparator

A. Required Components

- One μA741 op-amp.

B. Required Devices

- Two channel Oscilloscope.
- Dual Dc power supply.
- Function generator.

C. Procedure

- Construct the circuit shown in Fig.26.
- Adjust the function generator to provide a square wave of peak voltage of 2.0 V and frequency 1 KHz.
- Display both the input and output signals on your oscilloscope.
- Give your comments.
- Repeat with other frequencies of 100 Hz, 10 KHz, and 1 MHz.

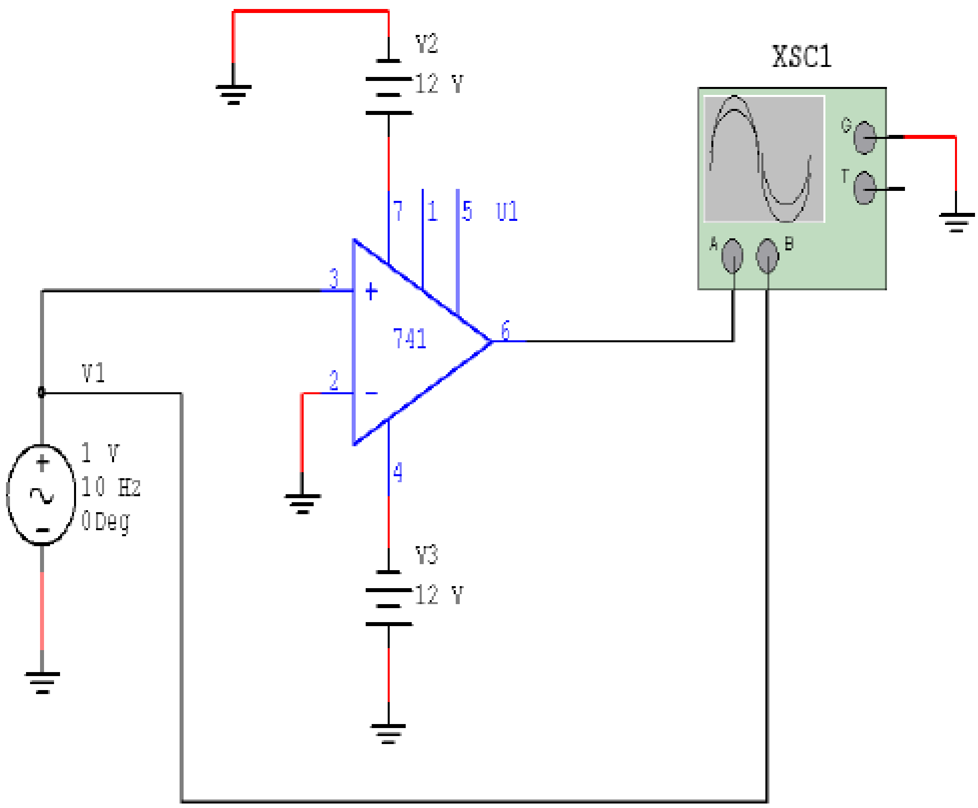


Fig.26 Comparator Operational Amplifier

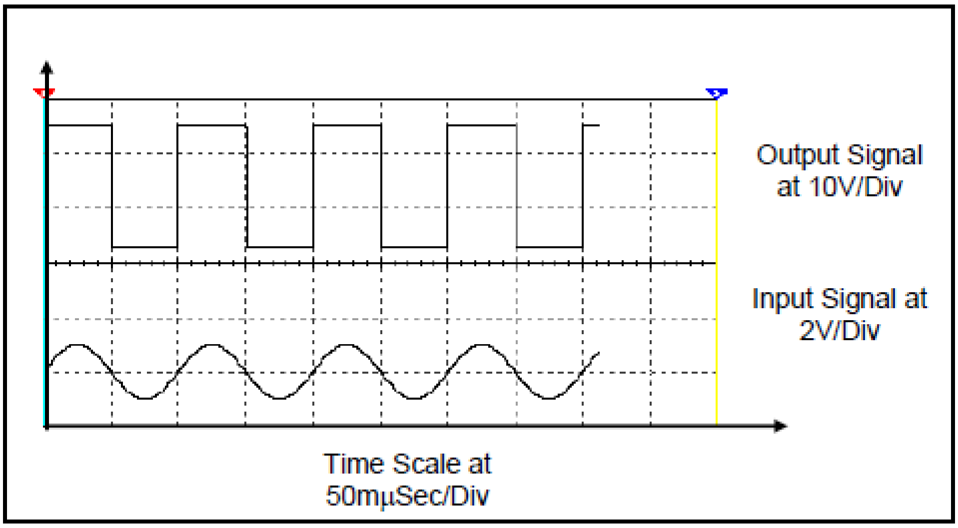


Fig.27 input and output signals of a comparator op-amp

التجربة الخامسة

Active Filters Based on Operational Amplifiers.

Experiment Title:

- Active Filters Based on Operational Amplifiers.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Passive filters.
- Op-amp characteristics.
- Frequency response of passive and active circuits.

II.1 2nd Order Low Pass Filter

A. Required Components

- One μA741 op-amp.
- Two 1 KΩ resistors of 1/2 watt power rating.
- Two 100 Ω resistors of 1/2 watt power rating.
- Two 0.1 μF capacitors of 20 volts rating.

B. Required Devices

- Function generator.
- Digital multimeter.
- Dual DC power supply.

C. Procedure

- Connect the circuit shown in Fig.13.
- Adjust the function generator to provide a sinusoidal wave of a peak-to-peak voltage of 1 volt and variable frequency.
- Change the dunction generator frequency and measure the output volatge at each frequency according to Table.1.
- Sketch the resulting frequency response.
- Compute the cutoff frequency, and the maximum gain.
- Give your comments.

III.1 2^{nd} Low Pass Filter

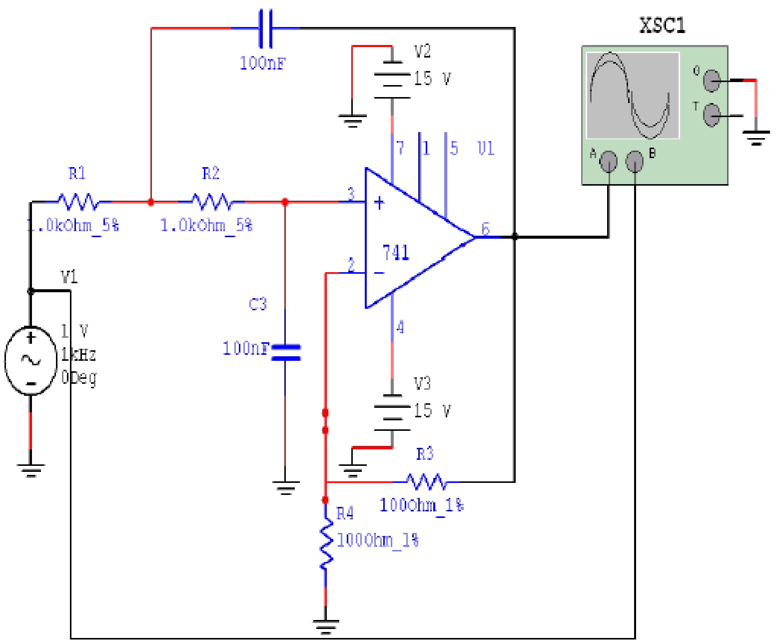
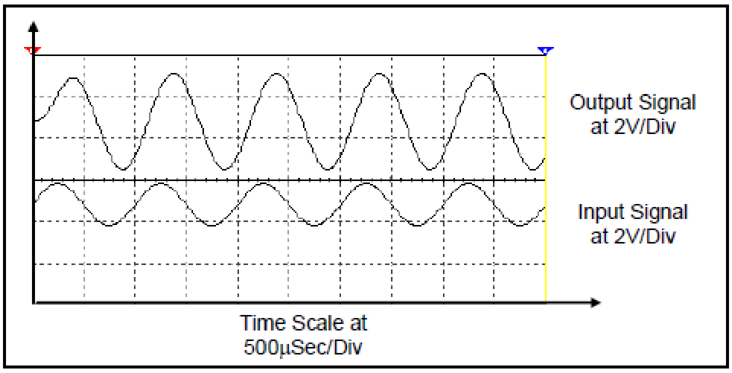


Fig.13 Second Order LPF



- *An input signal of frequency < cutoff frequency*

II.2 2^{nd} Order High Pass Filter

A. Required Components

- One μA741 op-amp.
- One 1 KΩ resistors of 1/2 watt power rating.
- Two 100 Ω resistors of 1/2 watt power rating.
- Two 0.1 μF capacitors of 20 volts rating.

B. Required Devices

- Function generator.
- Digital multimeter.
- Dual DC power supply.

C. Procedure

- Connect the circuit shown in Fig.14.
- Adjust the function generator to provide a sinusoidal wave of a peak-to-peak voltage of 1 volt and variable frequency.
- Change the dunction generator frequency and measure the output volatge at each frequency according to Table.2.
- Sketch the resulting frequency response.
- Compute the cutoff frequency, and the maximum gain.
- Give your comments.

III.2 2nd High Pass Filter

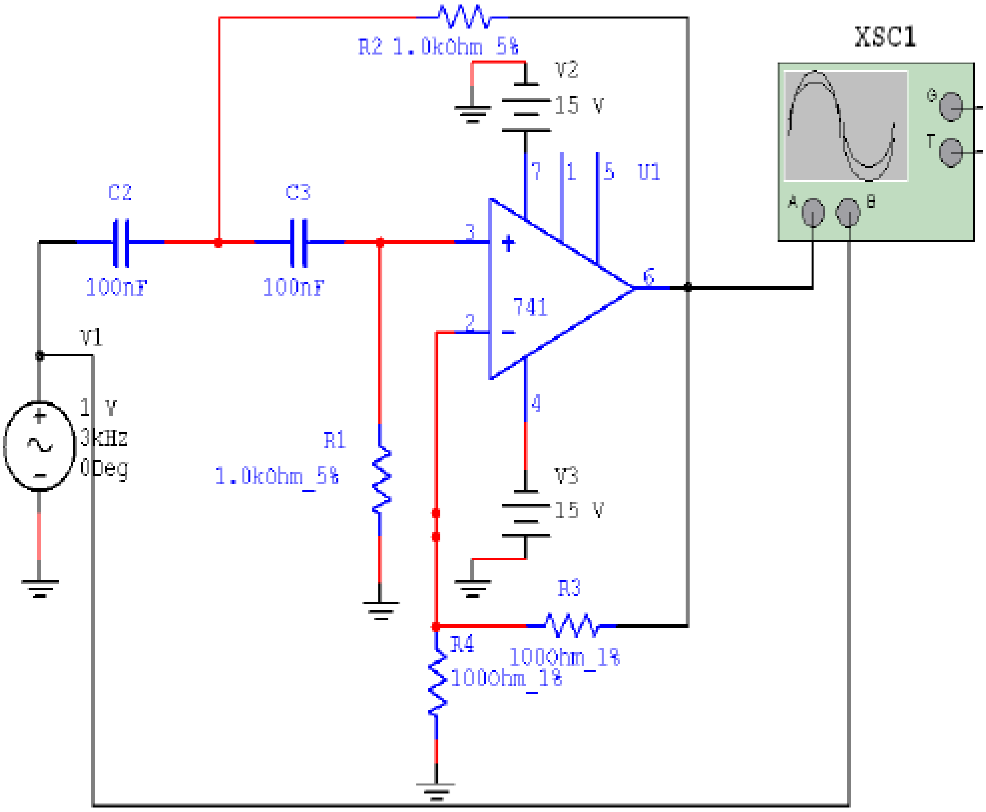
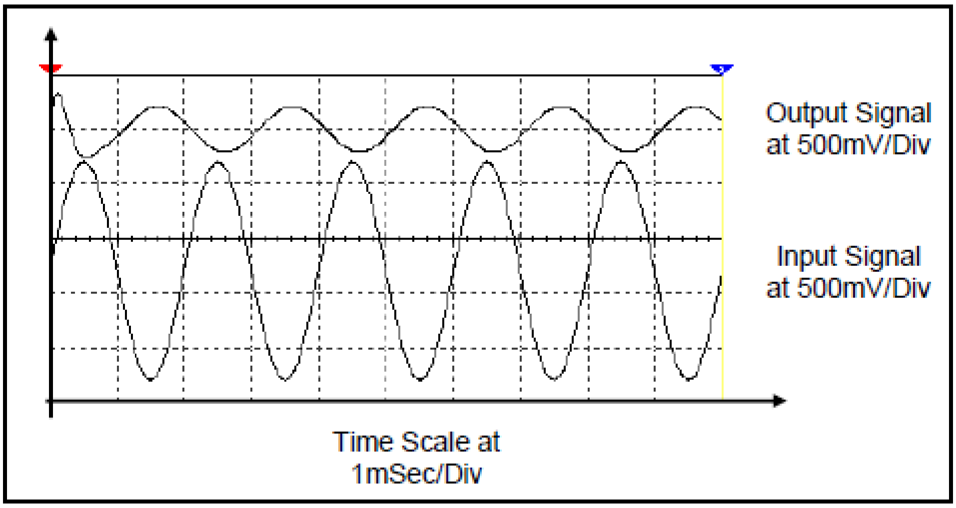
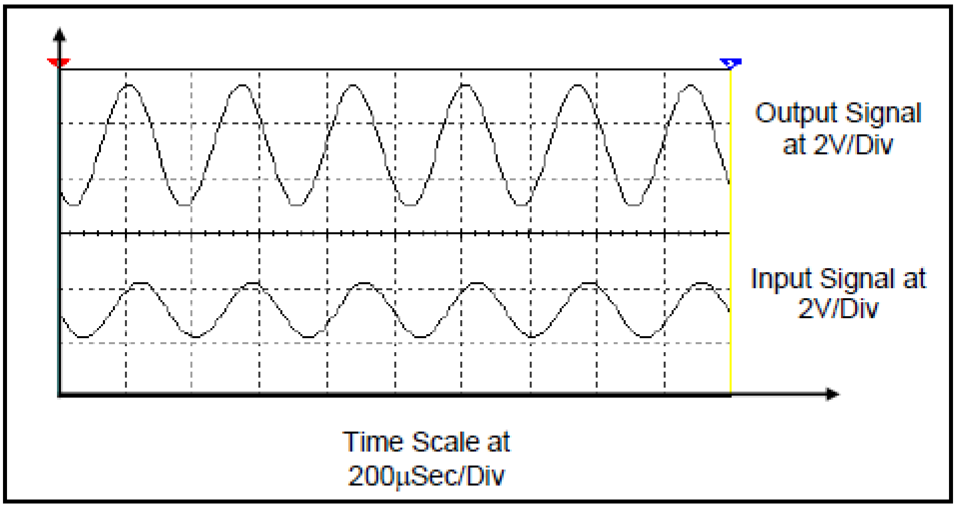


Fig.14 Second Order HPF



An input signal of frequency < cutoff frequency



An input signal of frequency > cutoff frequency

II.3 2^{nd} Order Band Pass Filter

A. Required Components

- One μA741 op-amp.
- One 50 MΩ resistors of 1/2 watt power rating.
- One 2 Ω resistors of 1/2 watt power rating.
- Two 10 nF capacitors of 20 volts rating.

B. Required Devices

- Function generator.
- Digital multimeter.
- Dual DC power supply.

C. Procedure

- Connect the circuit shown in Fig.15.
- Adjust the function generator to provide a sinusoidal wave of a peak-to-peak voltage of 1 volt and variable frequency.
- Change the dunction generator frequency and measure the output volatge at each frequency according to Table.4.
- Sketch the resulting frequency response.
- Compute the cutoff frequency, and the maximum gain.
- Give your comments.

III.3 2nd Band Pass Filter

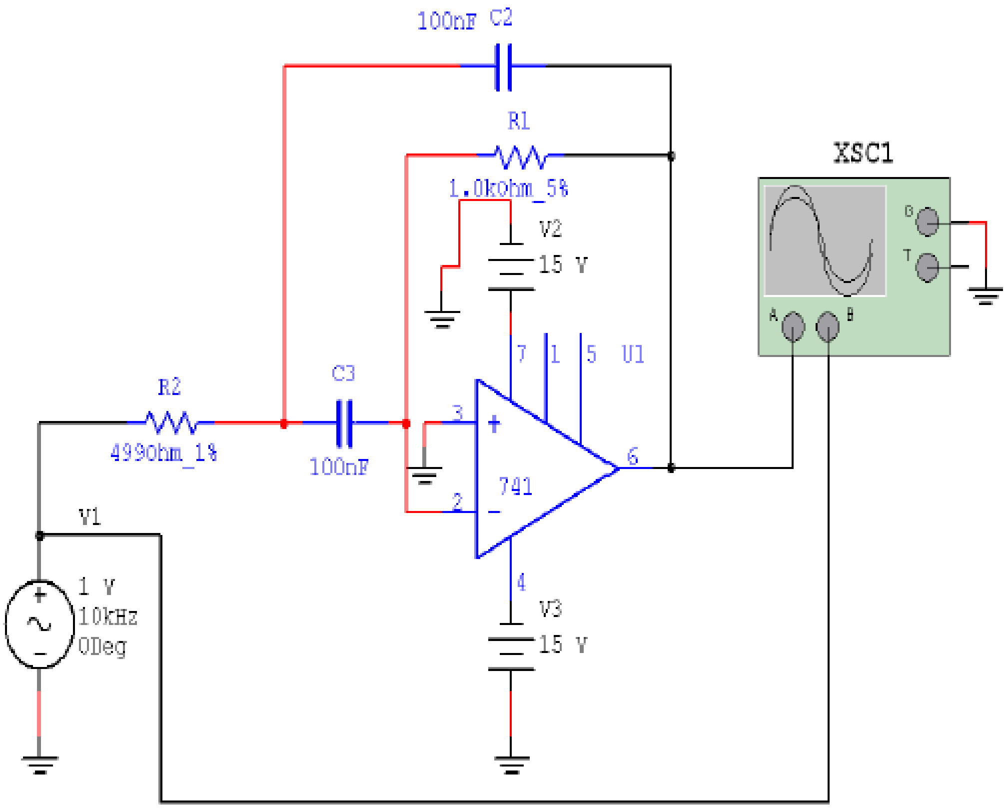
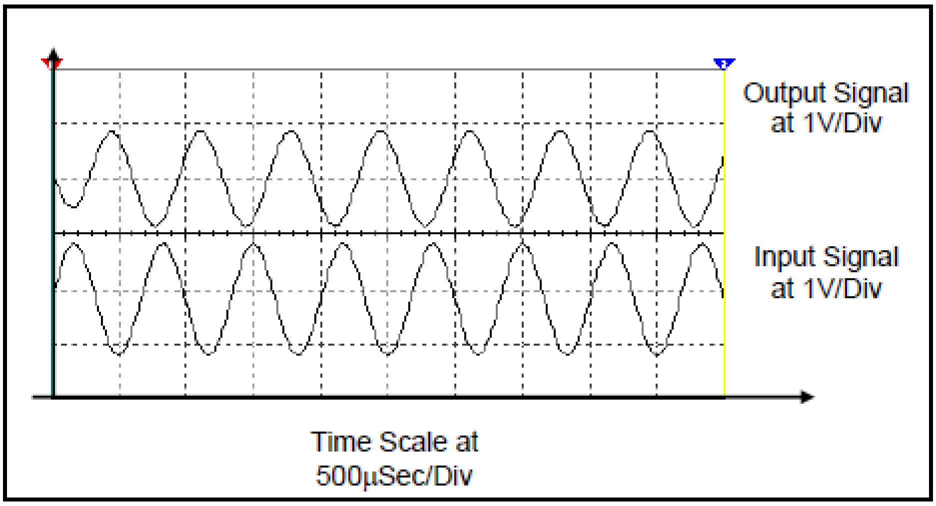


Fig.15 Second Order BPF



An input signal of frequency inside the bandwidth

II.4 3^{rd} Order Band Reject Filter

A. Required Components

- One μA741 op-amp.
- Four 1.5 kΩ resistors of 1/2 watt power rating.
- One 10 kΩ resistor of 1/2 watt power rating.
- One 2 kΩ resistor of 1/2 watt power rating.
- Four 0.1 μF capacitors of 20 volts rating.

B. Required Devices

- Function generator.
- Digital multimeter.
- Dual DC power supply.

C. Procedure

- Connect the circuit shown in Fig.16.
- Adjust the function generator to provide a sinusoidal wave of a peak-to-peak voltage of 1 volt and variable frequency.
- Change the dunction generator frequency and measure the output volatge at each frequency according to Table.3.
- Sketch the resulting frequency response.
- Compute the cutoff frequency, and the maximum gain.
- Give your comments.

III.4 3rd Band Reject Filter

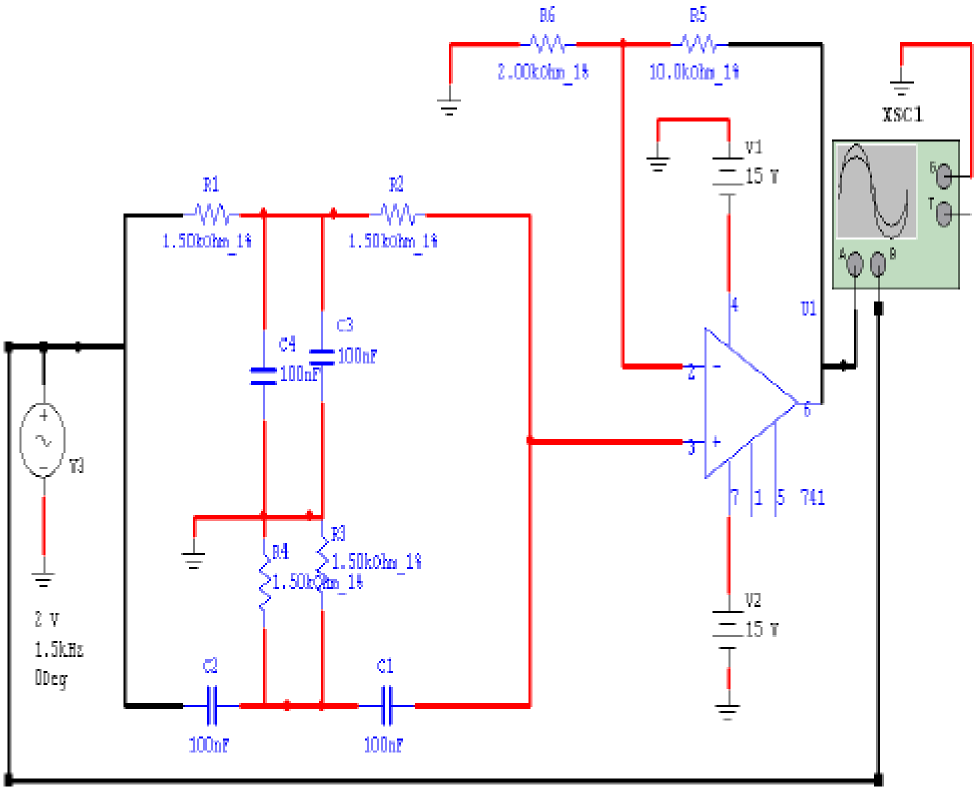
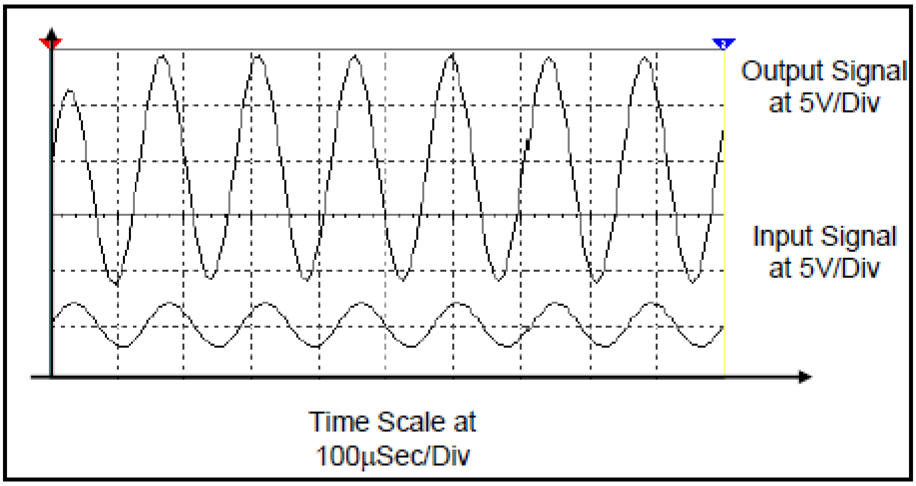
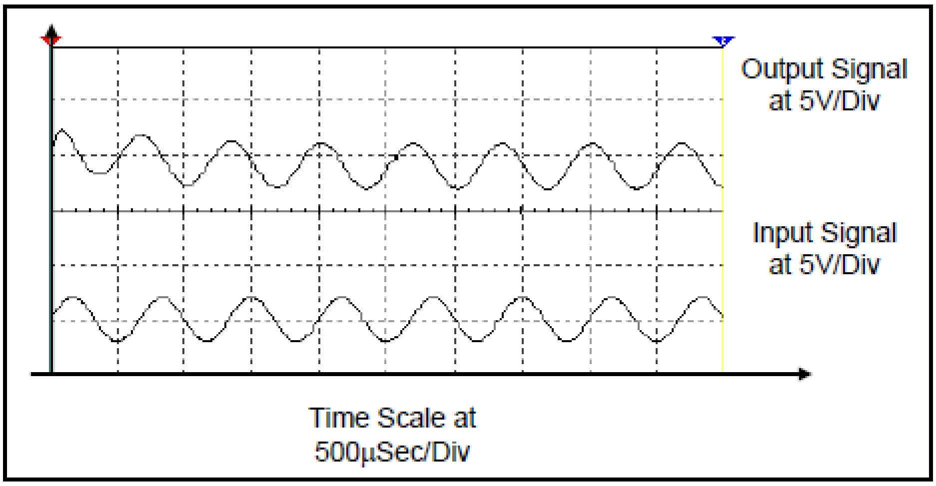


Fig.16 3rd order notch (BRF) filter

■



The upper signal is the output waveform due to a 7 kHz input signal drawn in the lower part of the figure



The upper signal is the output waveform due to a 1.5 kHz input signal drawn in the lower part of the figure

▪

Table.1 Results of low pass filter

f (Hz)	500	1000	1200	1400	1591	1800	2000	3000	5000
$V_o(V)$									
$\|V_o/V_i\|$									

Table.2 Results of high pass filter									
f (Hz)	500	1000	1200	1400	1591	1800	2000	3000	5000
$V_o(V)$									
$\lvert V_o/V_i \rvert$									

Table.3 Results of band pass filter									
f (Hz)	500	1000	1200	1400	1591	1800	2000	3000	5000
$V_o(V)$									
$\lvert V_o/V_i \rvert$									

Table.4 Results of band reject filter									
f (Hz)	100	3000	500	1000	2000	2500	3000	3500	4000
$V_o(V)$									
$\lvert V_o/V_i \rvert$									

التجربة السادسة

.Oscillators

Experiment Title:

- Oscillators.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-request:

- Feed back structures.
- The differences between negative and positive feed back structures.
- Op-amp analysis.

Part-II: Experiment Procedure

II.1 Wien Bridge Oscillator

A. Required Components

- One μA741 operational amplifier.
- Three 10- kΩ resistors of 1/2 watt power rating.
- Two 1-nF capacitors of 20 volts ratings.
- One 20-kΩ resistor of 1/2 watt power rating.

B. Required Devices

- Dual stabilized power supply.

- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.5.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Compute the frequency of oscillation using E.15.
- Give your comments.

III.1 Wien Bridge Oscillator

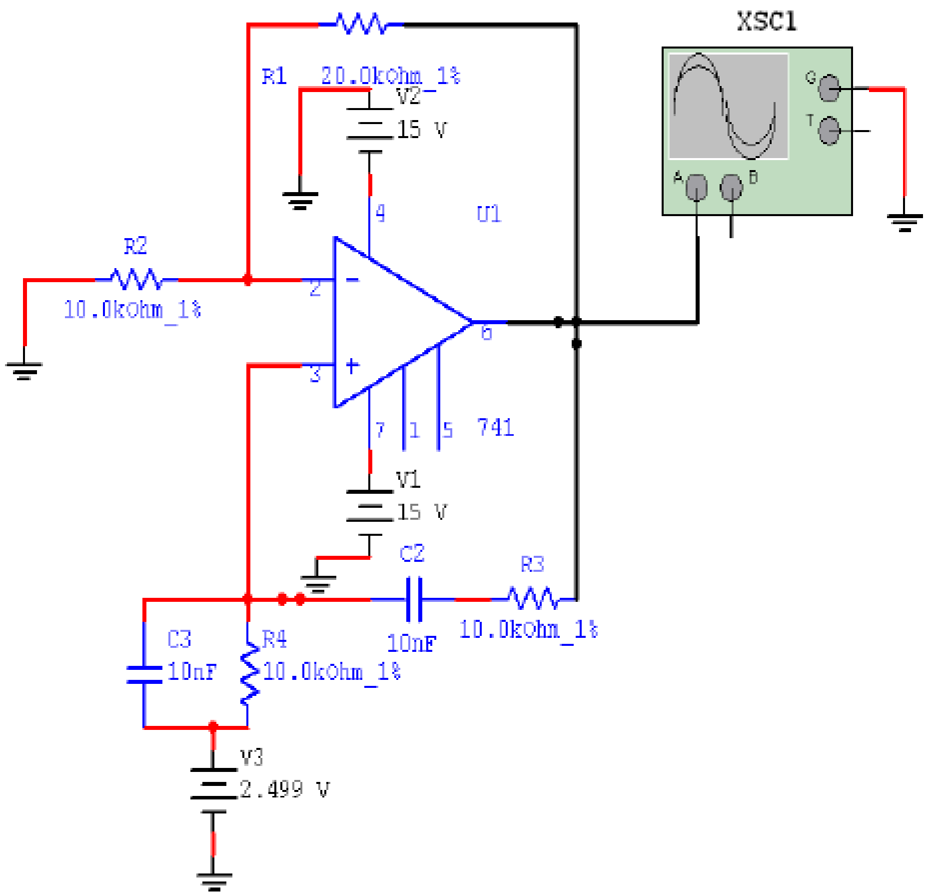


Fig.5 Wien Bridge Oscillator

II.2 RC-Phase Shift Oscillator

A. Required Components

- One μA741 operational amplifier.
- Three 10- kΩ resistors of 1/2 watt power rating.
- Three 10-nF capacitors of 20 volts ratings.
- One 180-kΩ resistor of 1/2 watt power rating.
- One 1.5-MΩ resistor of 1/2 watt power rating.

B. Required Devices

- Dual stabilized power supply.
- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.7.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Compute the frequency of oscillation using E.27.
- Give your comments.

III.2 RC-Phase Shift Oscillator

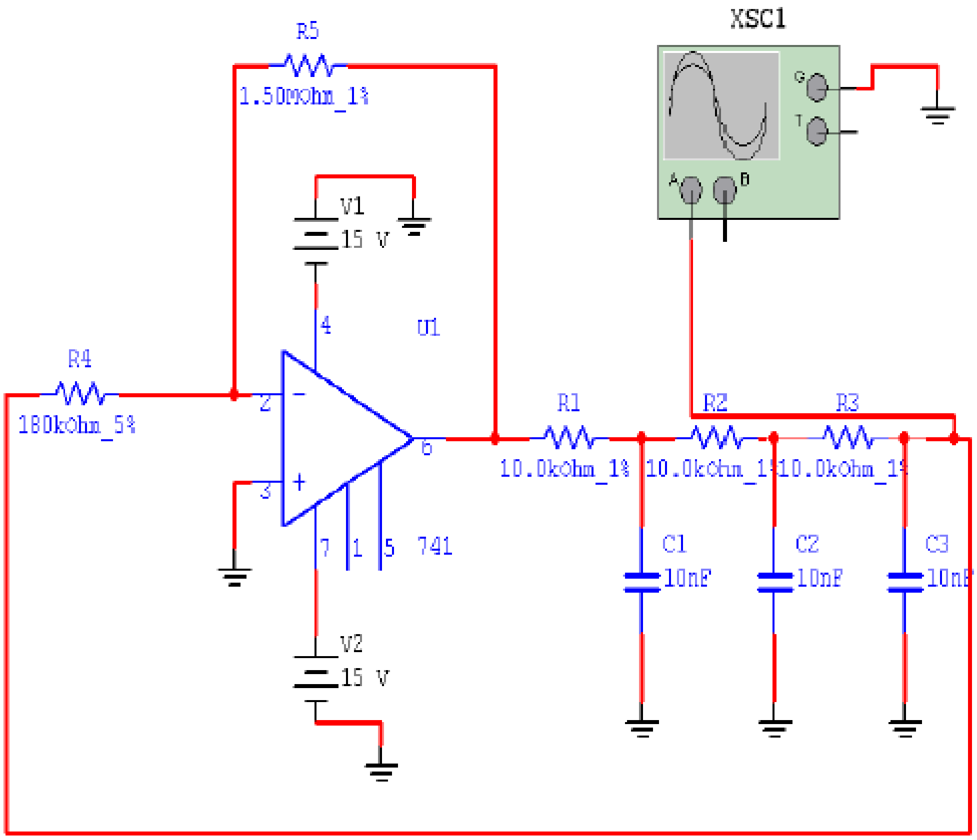


Fig.7 RC-Phase Shift Oscillator

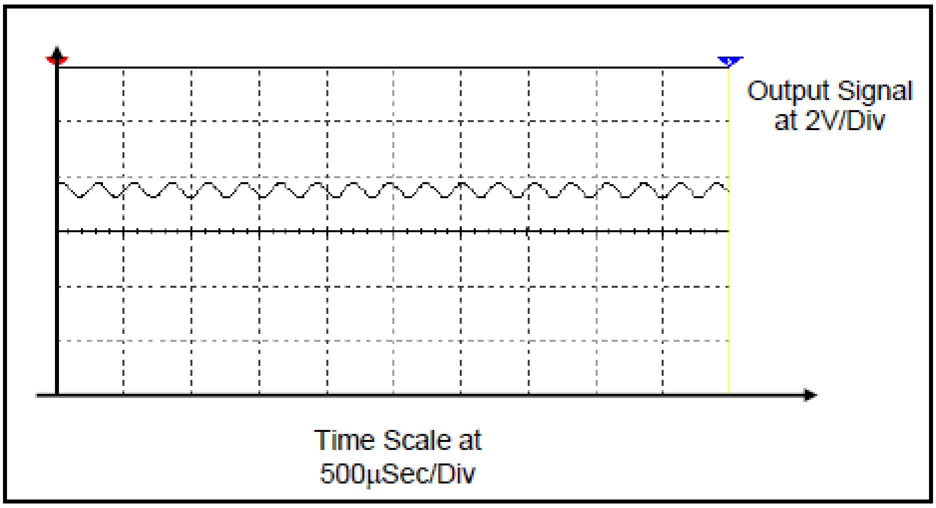


Fig.8 RC-Phase Shift Oscillator

II.3 Colpitts Oscillator

A. Required Components

- One μA741 operational amplifier.
- One 10-pF capacitors of 20 volts ratings.
- One 39-pF capacitor of 20 volts ratings.
- One 1-mH of 500 mA ratings.
- One 20-kΩ resistor of 1/2 watt power rating.
- One 5.6-MΩ resistor of 1/2 watt power rating.

B. Required Devices

- Dual stabilized power supply.
- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.9.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Compute the frequency of oscillation using E.32.
- Give your comments.

III.3 Colpitts Oscillator

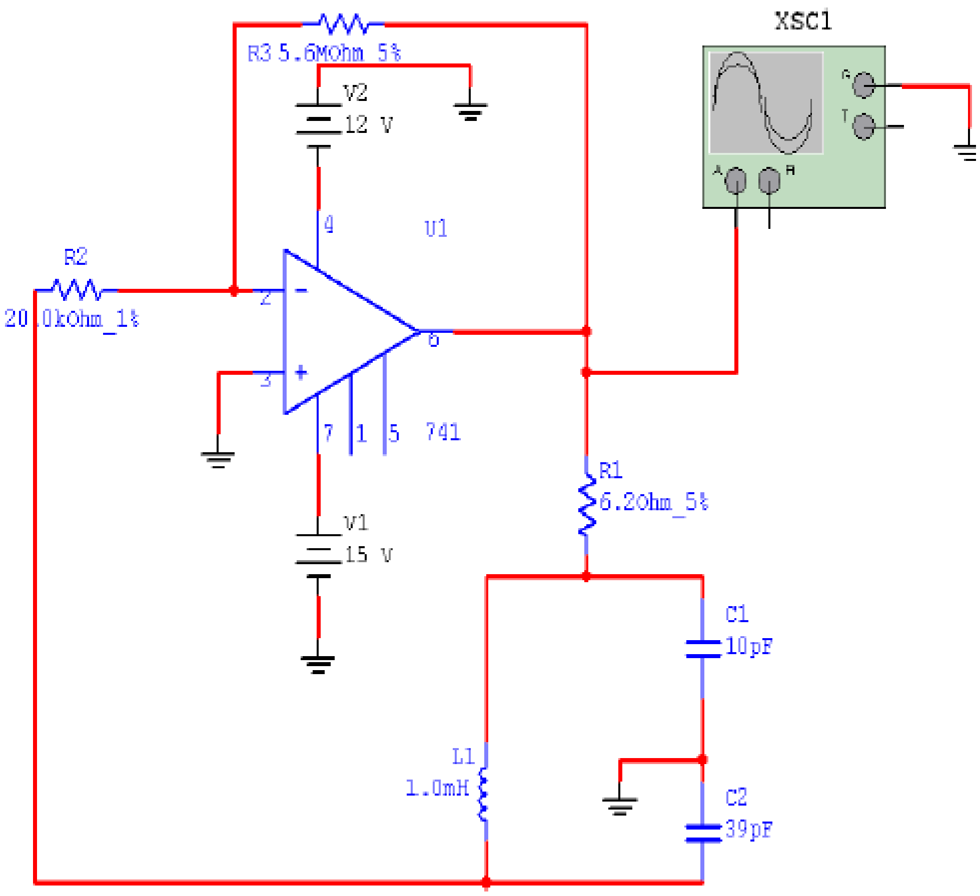


Fig.9 Colpitts Oscillator

II.4 Hartely Oscillator

A. Required Components

- One μA741 operational amplifier.
- One 10-pF capacitors of 20 volts ratings.
- One 3.9-mH inductor of 500 mA ratings.
- One 1.0-mH inductor of 500 mA ratings.
- One 20-kΩ resistor of 1/2 watt power rating.
- One 5.6-MΩ resistor of 1/2 watt power rating.

B. Required Devices

- Dual stabilized power supply.
- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.11.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Compute the frequency of oscillation using E.33.
- Give your comments.

III.4 Hartley Oscillator

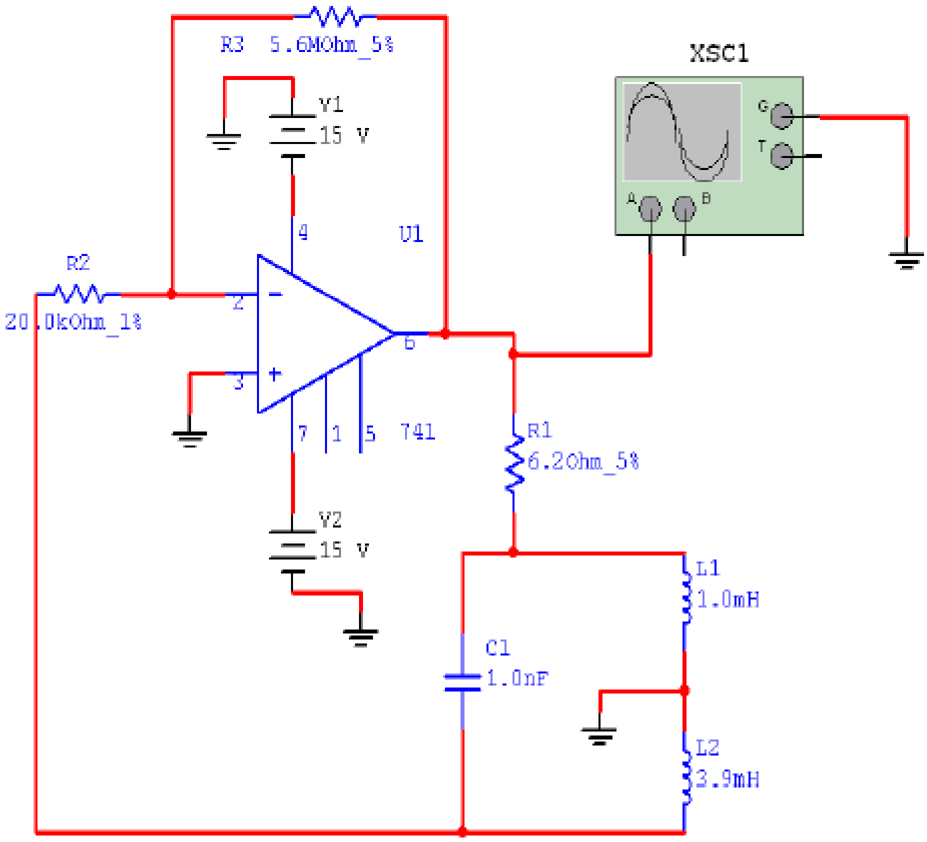
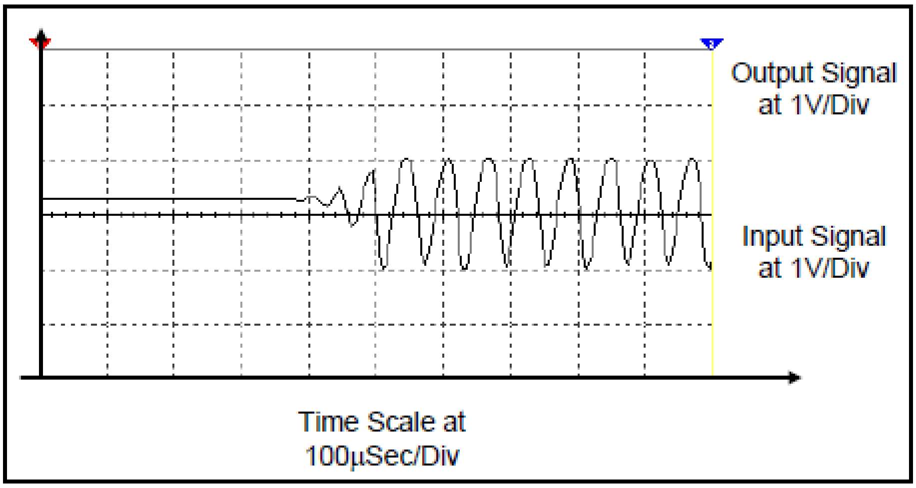


Fig.11 Hartley Oscillator



▪ *Fig.12 Output waveform of Hartley oscillator*

II.5 Sawtooth Oscillator

A. Required Components

- Two μA741 operational amplifiers.
- Two 1N4009 diodes.
- Two 100-kΩ resistors of 1/2 watt power rating.
- One 120-kΩ resistor of 1/2 watt power rating.
- One 5.6-kΩ resistor of 1/2 watt power rating.
- One 100-nF capacitors of 20 volts ratings.

B. Required Devices

- Dual stabilized power supply.
- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.13.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Give your comments.

III.5 Saw Tooth Oscillator

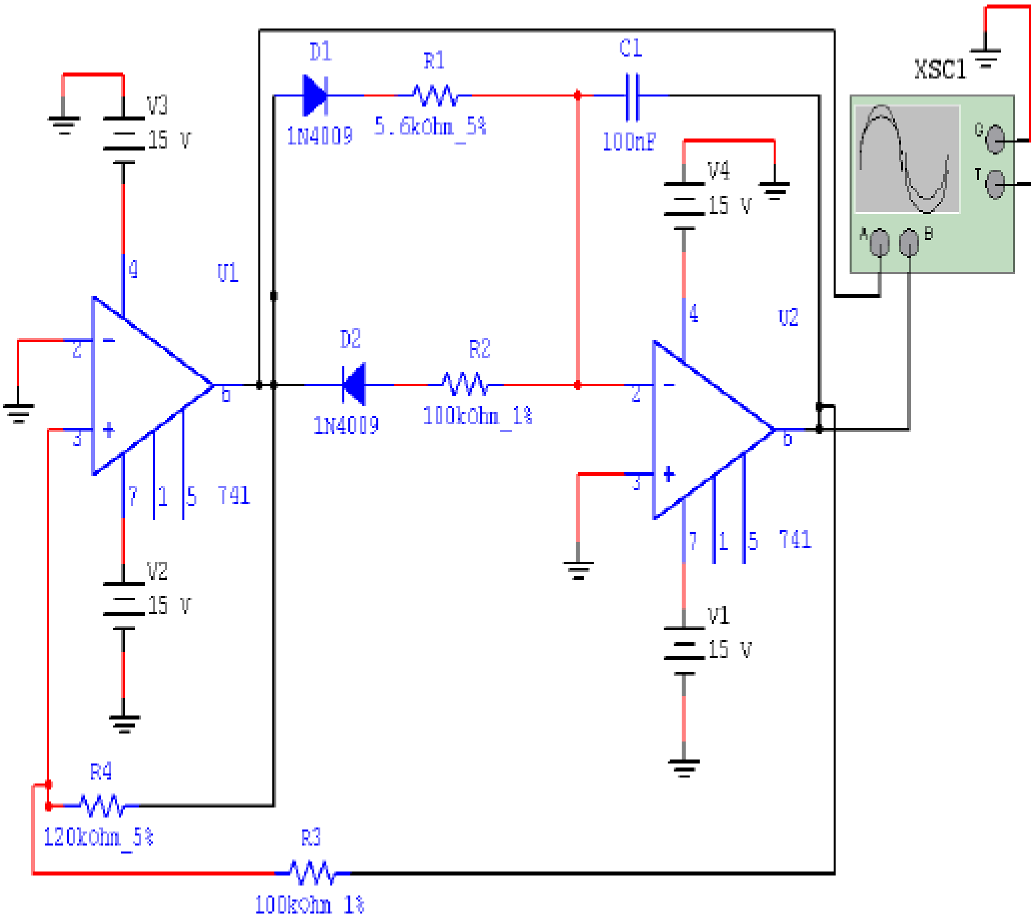


Fig.13 Saw tooth

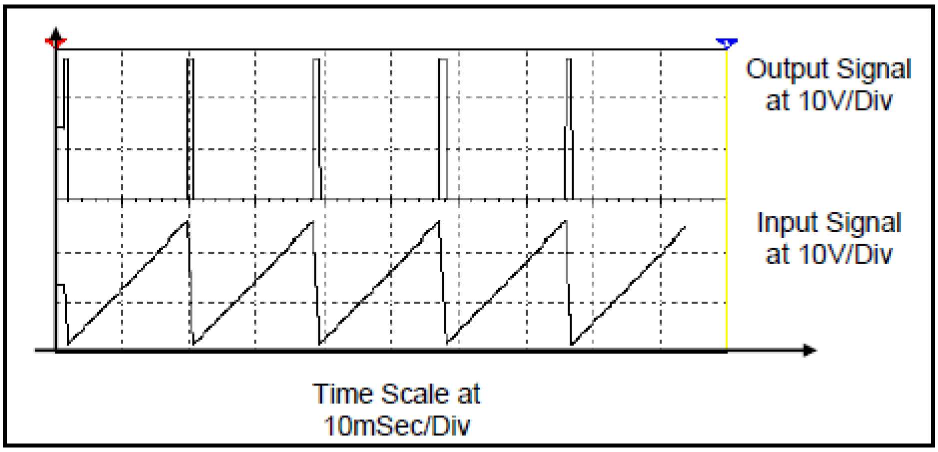


Fig.14 the output of a saw tooth wave oscillator

II.6 Triangle Wave Oscillator

A. Required Components

- Two μA741 operational amplifiers.
- One 2.2-kΩ resistors of 1/2 watt power rating.
- One 8.2-kΩ resistor of 1/2 watt power rating.
- One 10.0-kΩ resistor of 1/2 watt power rating.
- One 100-nF capacitors of 20 volts ratings.

B. Required Devices

- Dual stabilized power supply.
- Oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.15.
- Connect Ch.A of the oscilloscope to display the output waveform.
- Compute the frequency of the output waveform from the oscilloscope screen.
- Give your comments.

III.6 Triangle Wave Oscillator

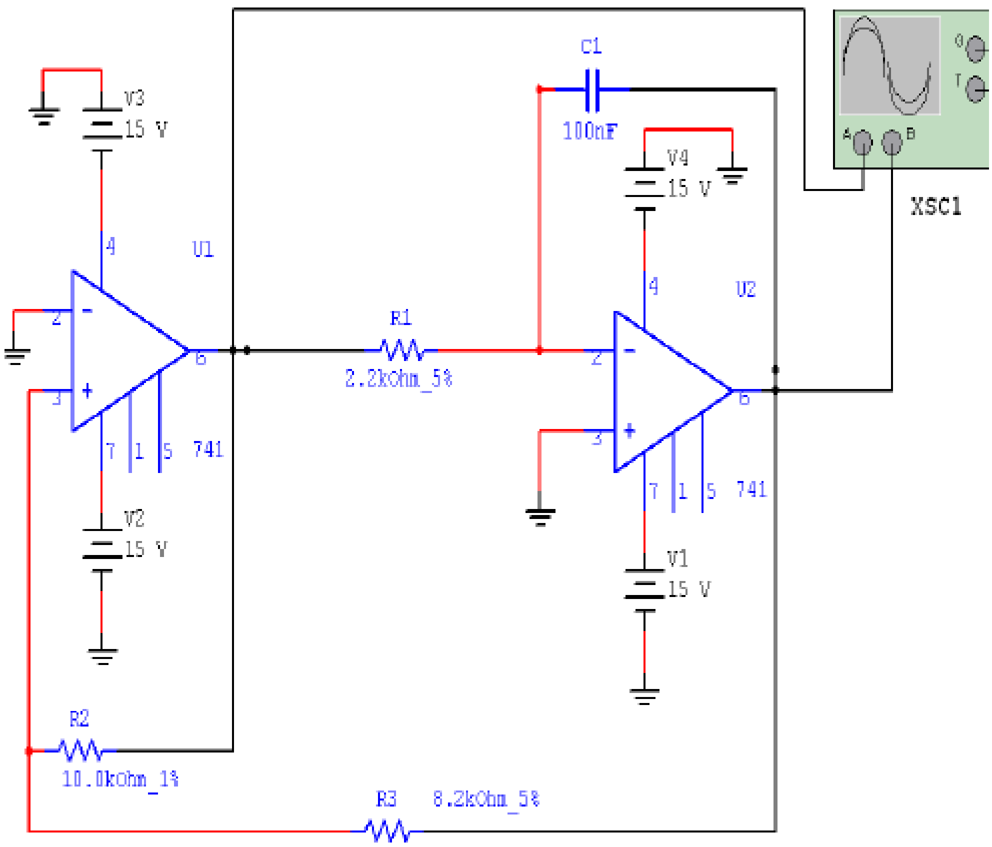


Fig.15 Triangle wave

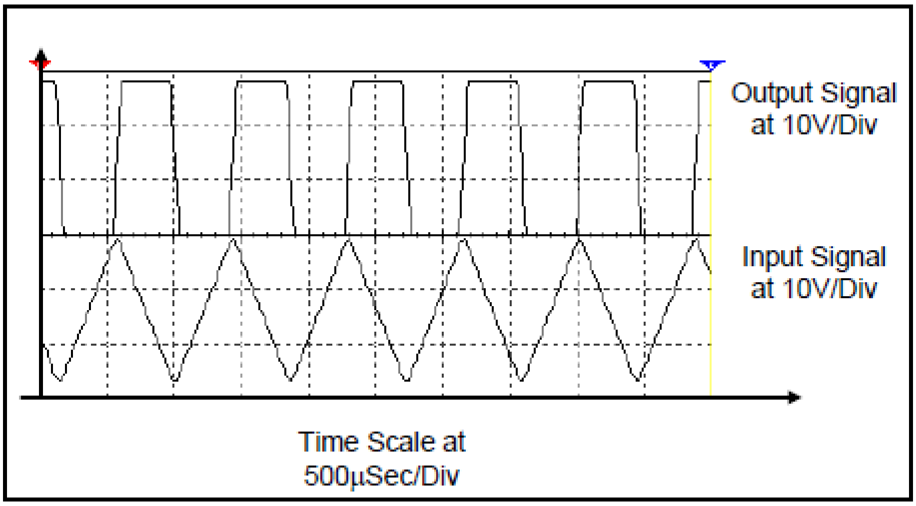


Fig.16 the output of a triangle wave oscillator

التجربة السابعة

.Timing Circuits using IC 555

Experiment Title:

- Timing Circuits Using 555 IC.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Reading the IC datasheets.
- The operation of op-amp comparators.
- The charging and discharging waveforms of a capacitor.

II.1 First Astable Circuit

A. Required Components

- One IC of LM555CM.
- Two 2 kΩ resistors of 1/2 watt power rating.
- One 680 Ω resistor of 1/2 watt power rating.
- One LED diode.
- One 10-nF capacitor of 20 volts rating.
- One 0.1-μF capacitor of 20 volts rating.

B. Required Devices

- Dual stabilized DC power supply.
- Two channel oscilloscope.

C. Procedure

- Connect the circuit shown in Fig.6.
- Connect the output terminal to Ch.A of the oscilloscope.
- Compute the charging time; t_H.
- Compute the discharging time; t_L.
- Compute the time period; t.
- Compute the duty cycle.
- Compute the frequency of oscillation.
- Give your comments.

Part-III: Computer Simulation

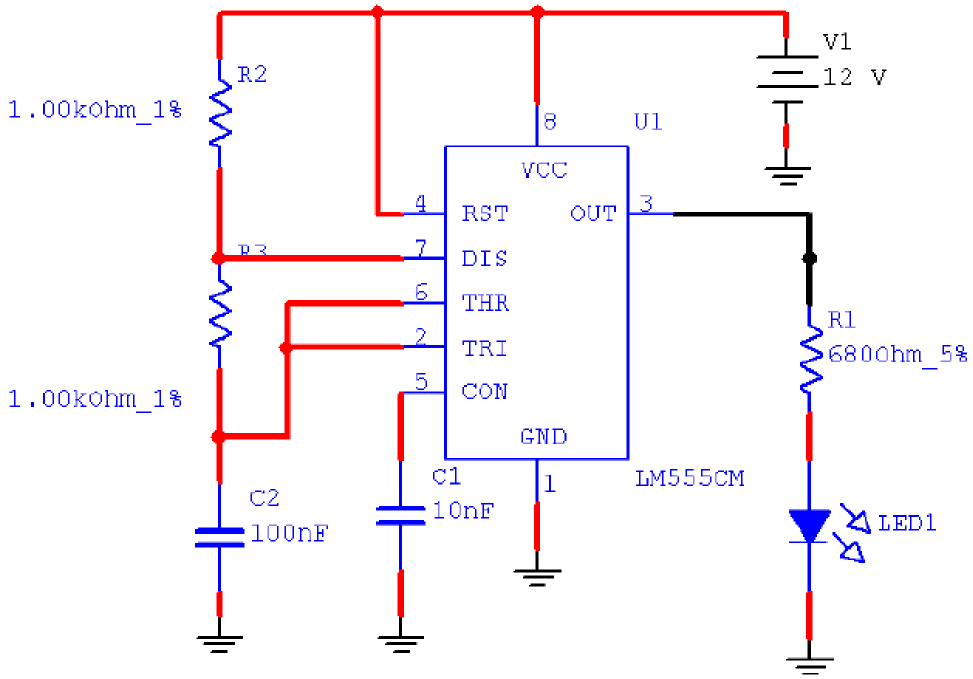


Fig.6 Astable 555 Circuit

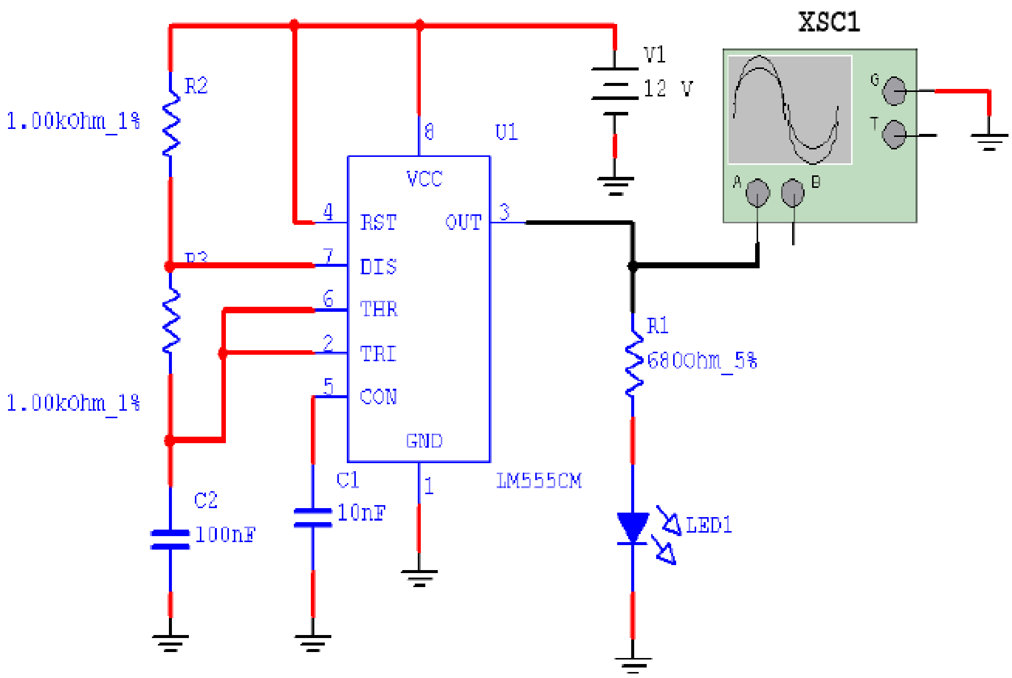


Fig.7 Astable 555 Circuit Connected with an Oscilloscope

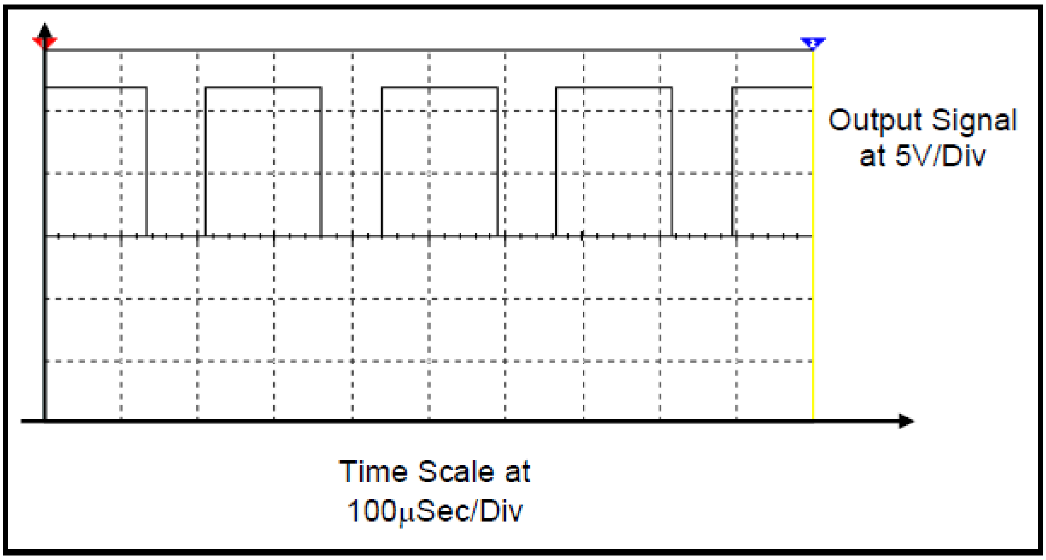


Fig.8 Output of Astable 555 Circuit

II.2 Second Astable Circuit

A. Required Components

- One IC of LM555CM.
- Two 2 kΩ resistors of 1/2 watt power rating.
- One 680 Ω resistor of 1/2 watt power rating.
- One LED diode.
- One diode of type 1N4009.
- One 10-nF capacitor of 20 volts rating.
- One 0.1-μF capacitor of 20 volts rating.

B. Required Devices

- Dual stabilized DC power supply.
- Two channel oscilloscope.

C. Procedure

- Connect the circuit shown in Fig.9.
- Connect the output terminal to Ch.A of the oscilloscope.
- Compute the charging time; t_H.
- Compute the discharging time; t_L.
- Compute the time period; t.
- Compute the duty cycle.
- Compute the frequency of oscillation.
- Give your comments.

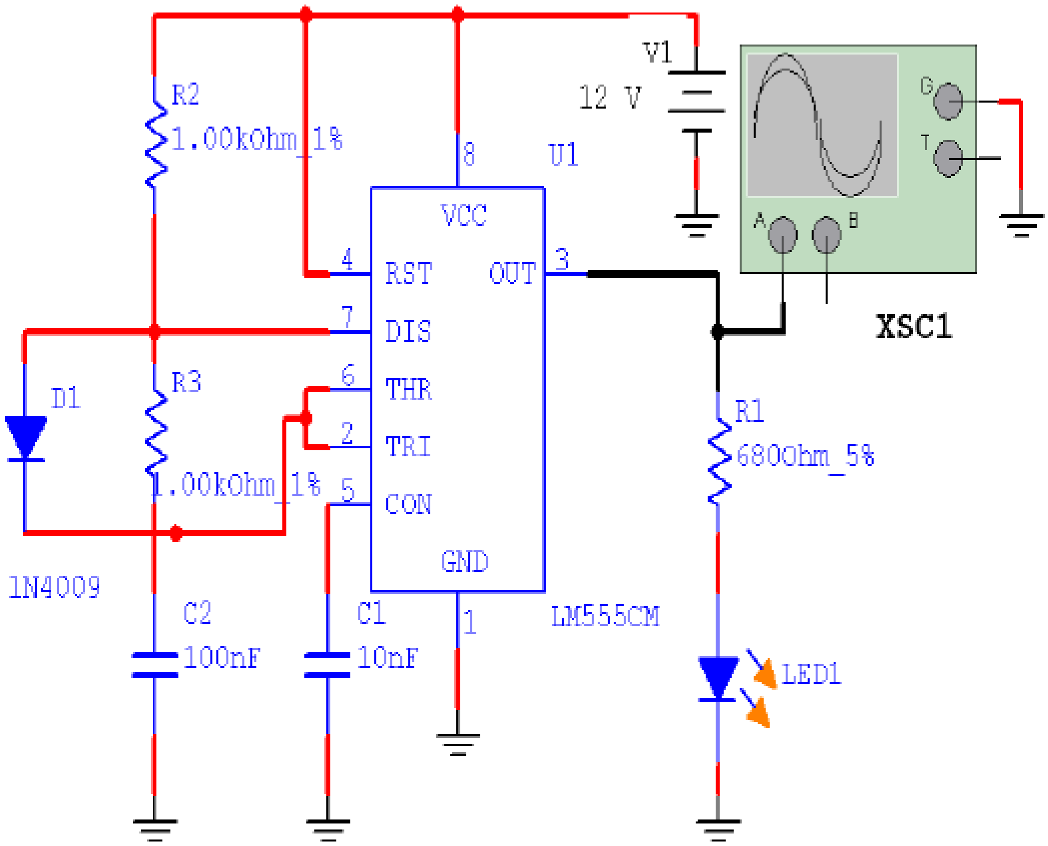


Fig.9 Symmetric Astable 555 Circuit

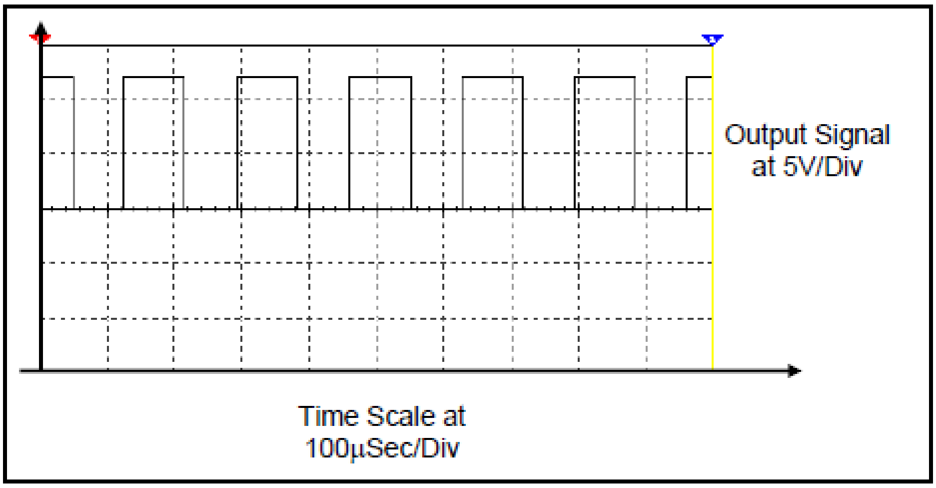


Fig.10 Symmetric Astable Output

II.3 Monostable Circuit

A. Required Components

- One IC of LM555CM.
- One 1 kΩ resistors of 1/2 watt power rating.
- One 10 kΩ resistors of 1/2 watt power rating.
- One 680 Ω resistor of 1/2 watt power rating.
- One LED diode.
- One 10-nF capacitor of 20 volts rating.
- One 0.1-μF capacitor of 20 volts rating.

B. Required Devices

- Dual stabilized DC power supply.
- Two channel oscilloscope.

C. Procedure

- Connect the circuit shown in Fig.11.
- Connect the output terminal to Ch.A of the oscilloscope.

- Compute the time, where the output is high; t.
- Compute the frequency of oscillation.
- Give your comments.

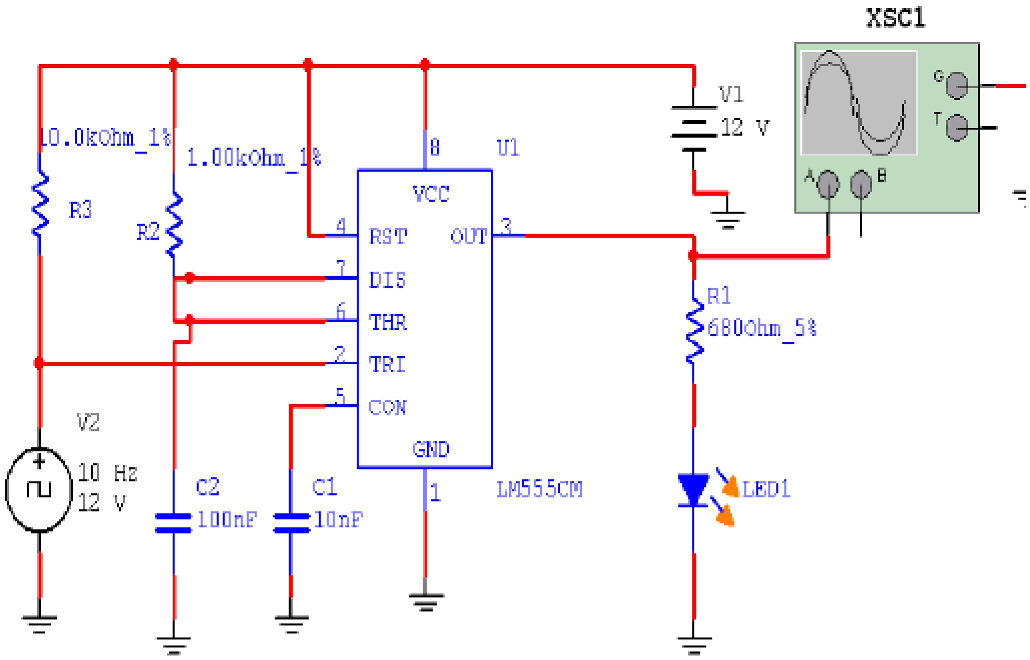


Fig.11 Monostable Circuit

-

التجربة الثامنة

.Flip Flops and Counters

Experiment Title:

- Flip Flops and Counters

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Fundamentals of logic gates.
- Combinational logic gates.
- Binary systems.
- Construction of timing diagram and truth table.

Part-II: Experiment Procedure

I.1 Realizing RS Flip-Flop Using NAND-Gates

A. Required Components

- One 74LS00 quad 2-input NAND gate.
- Two 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.

- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.18.
- Fill all the cells of Table.1.
- Give your comments.

Table.1 R/S flip flop truth table			
R	S	Q	$\overline{Q}$
0	0		
0	1		
1	0		
1	1		

III.1 Realizing R-S Flip Flop Using NAND-Gate

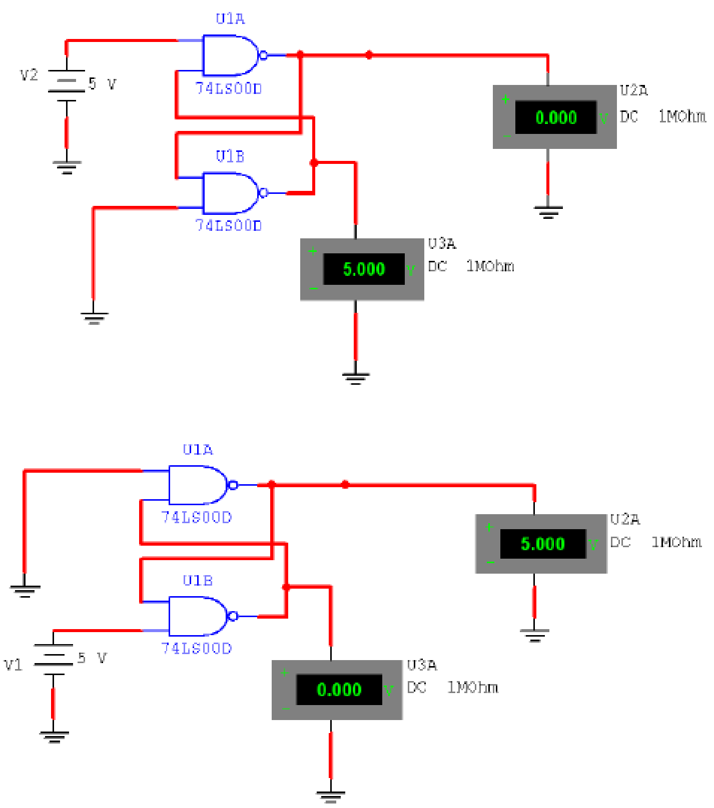


Fig.18 R-S flip flop

I.2 Realizing R/S Flip-Flop Using NOR-Gates

A. Required Components

- One 74LS02, quad with 2-input NOR gate.
- Two 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

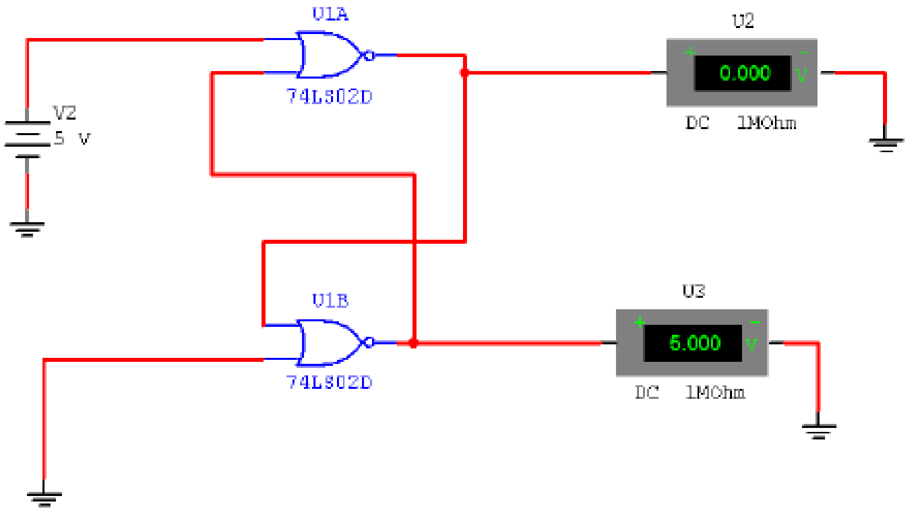
C. Procedure

- Construct the circuit shown in Fig.19.
- Fill all the cells of Table.2.
- Give your comments.

Table.2 R/S flip flop truth table

R	S	Q	$\overline{Q}$
0	0		
0	1		
1	0		
1	1		

III.2 Realizing R-S Flip Flop Using NOR-Gate



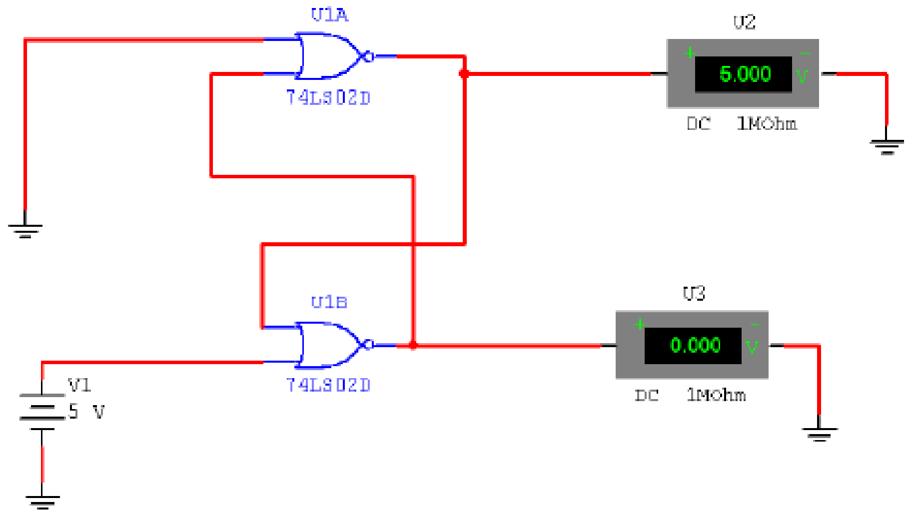


Fig.19 NOR-gate realization of an RS-flip flop

I.3 Realizing J-K Flip-Flop Using NAND-Gates

A. Required Components

- One 74LS00 quad two inputs NAND gate.
- One 74LS10 triple 3-input NAND gate.
- Two 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.20.
- Fill all the cells of Table.3.
- Give your comments.

Table.3 J-K flip flop truth table

J	K	Q	$\overline{Q}$
0	0		
0	1		
1	0		
1	1		

III.3 Realizing J-K Flip Flop Using NAND-Gate

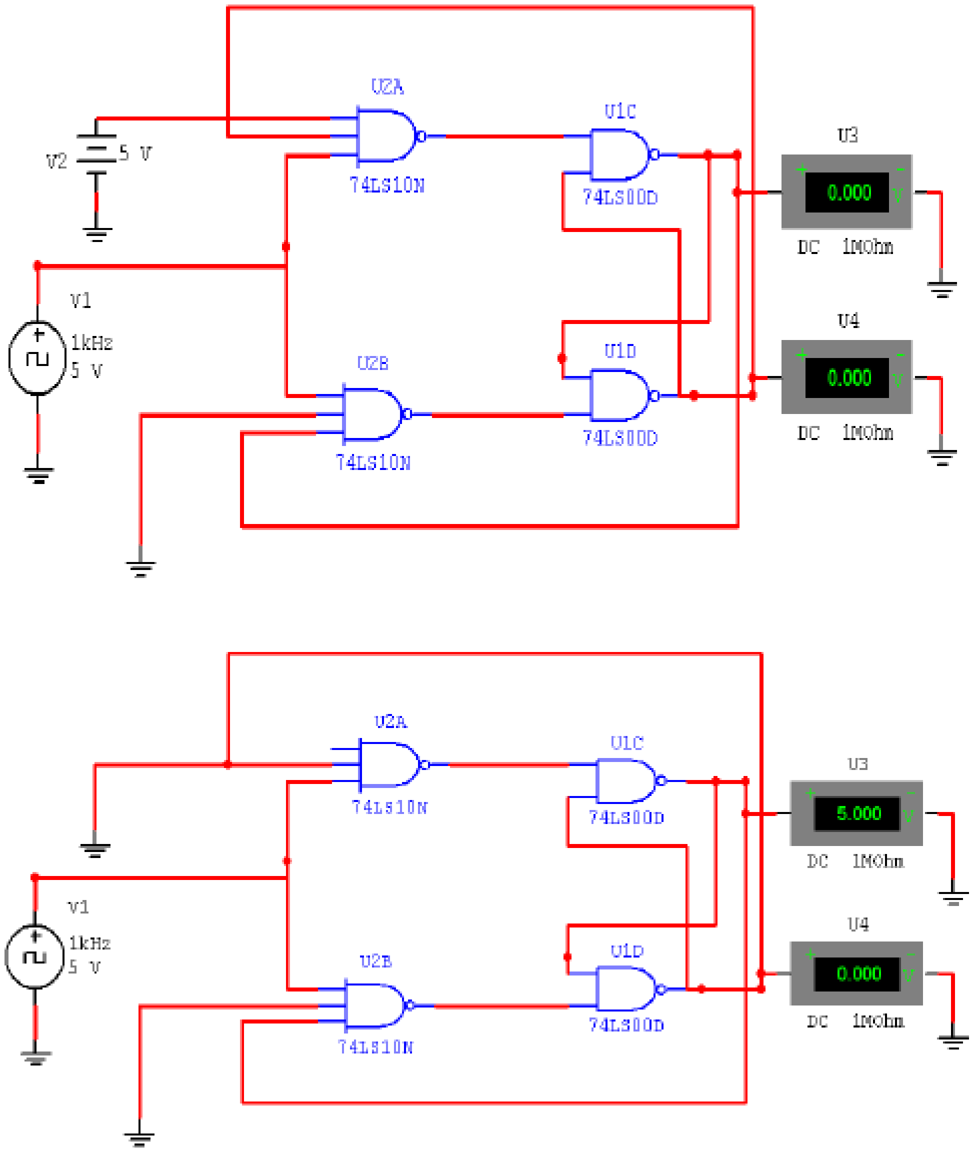


Fig.20 J-K flip flop using NAND gates

I.4 Realizing D Flip-Flop Using NAND-Gates

A. Required Components

- Three 74LS00 quad two inputs NAND gate.
- Two 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.21.
- Fill all the cells of Table.4.
- Give your comments.

Table.4 D flip flop truth table

D	Q	$\overline{Q}$
0		
1		

III.4 Realizing D Flip Flop Using NAND-Gate

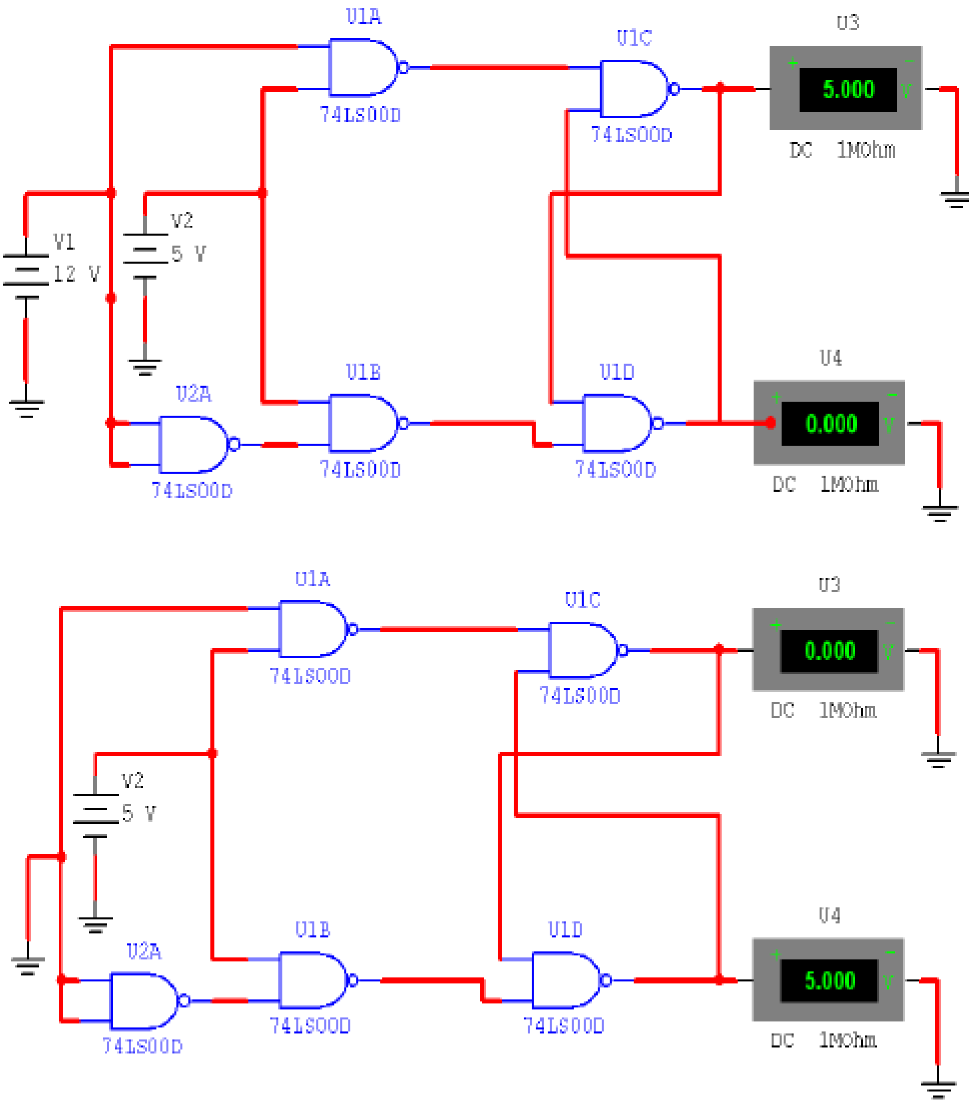


Fig.21 D-flip flop

I.5 Realizing Binary Counter Using J-K Flip Flops

A. Required Components

- Two 74LS106; dual J-K flip flop.
- Four 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.22.
- Display the output at each output bit on the oscilloscope.
- Give your comments.

III.5 Realizing Binary Counter Using J-K Flip Flop

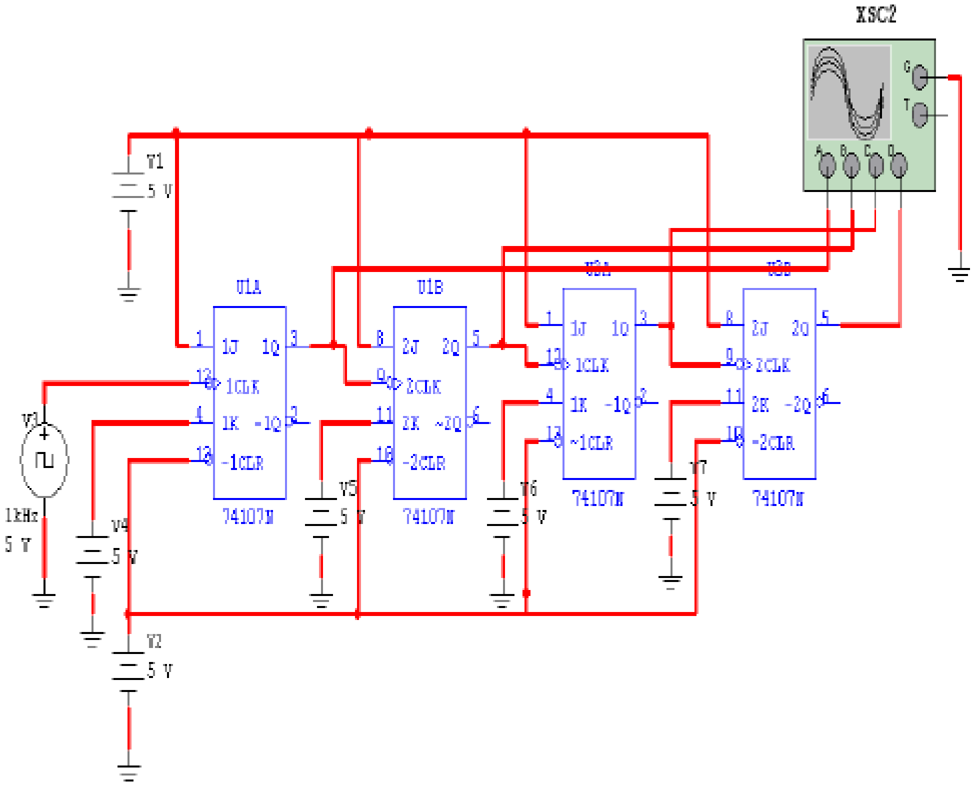
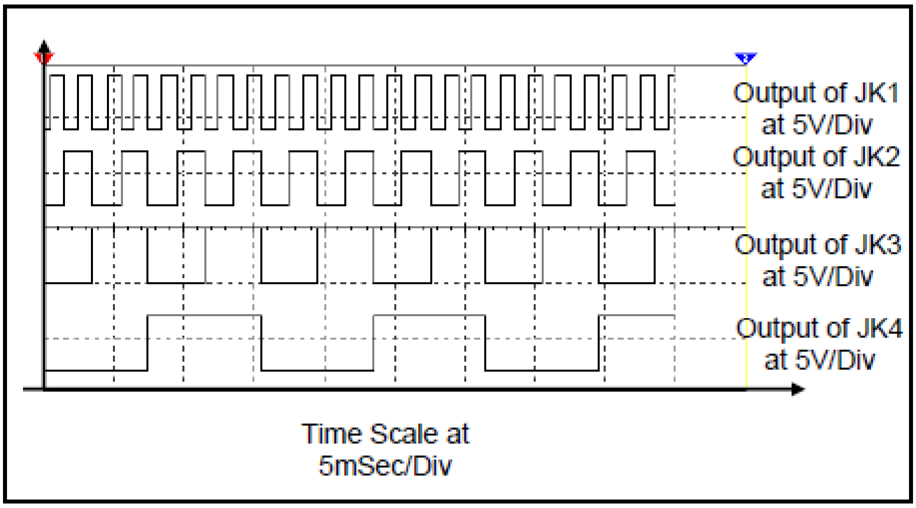


Fig.22 Binary Counter



The output voltage at the four bits from least to most significant

I.6 Realizing BCD Counter Using J-K Flip Flops

A. Required Components

- Two 74LS106; dual J-K flip flop.
- Four 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.23.
- Display the output at each output bit on the oscilloscope.
- Give your comments.

III.6 Realizing BCD Counter Using J-K Flip Flop

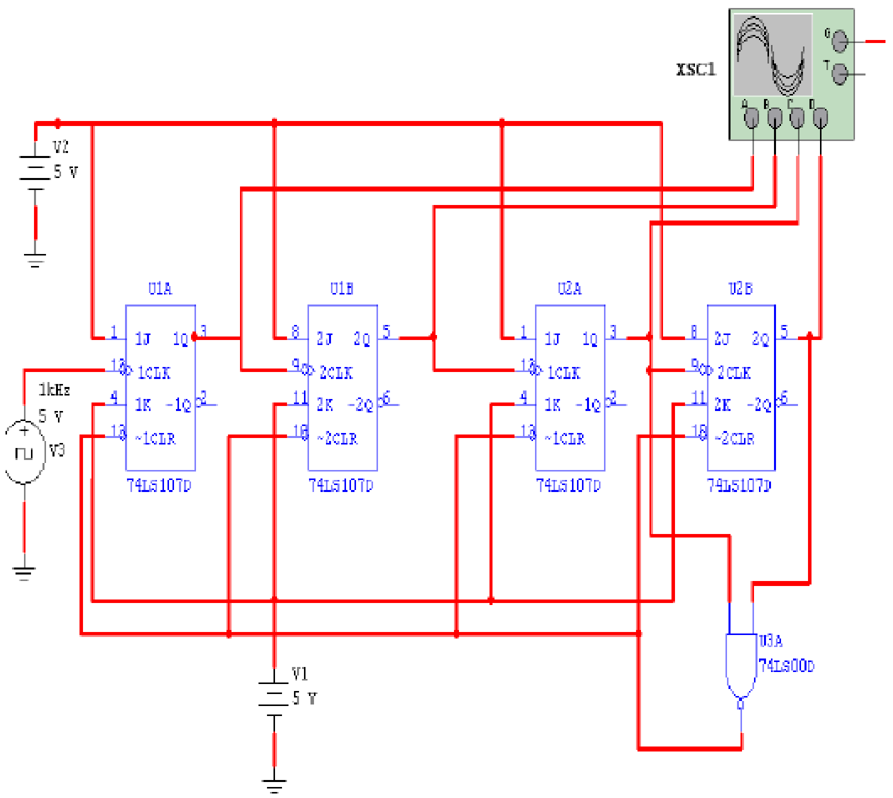


Fig.23 BCD counter

I.7 Realizing Frequency Divider Using J-K Flip Flops

A. Required Components

- Two 74LS106; dual J-K flip flop.
- Four 1-kΩ resistors of 1/2 watt power rating.

B. Required Devices

- Stabilized DC power supply; 5 volts.
- Two channel oscilloscope.

C. Procedure

- Construct the circuit shown in Fig.24.
- Display the output at each output bit on the oscilloscope.
- Give your comments.

III.7 Realizing Frequency Divider Using J-K Flip Flop

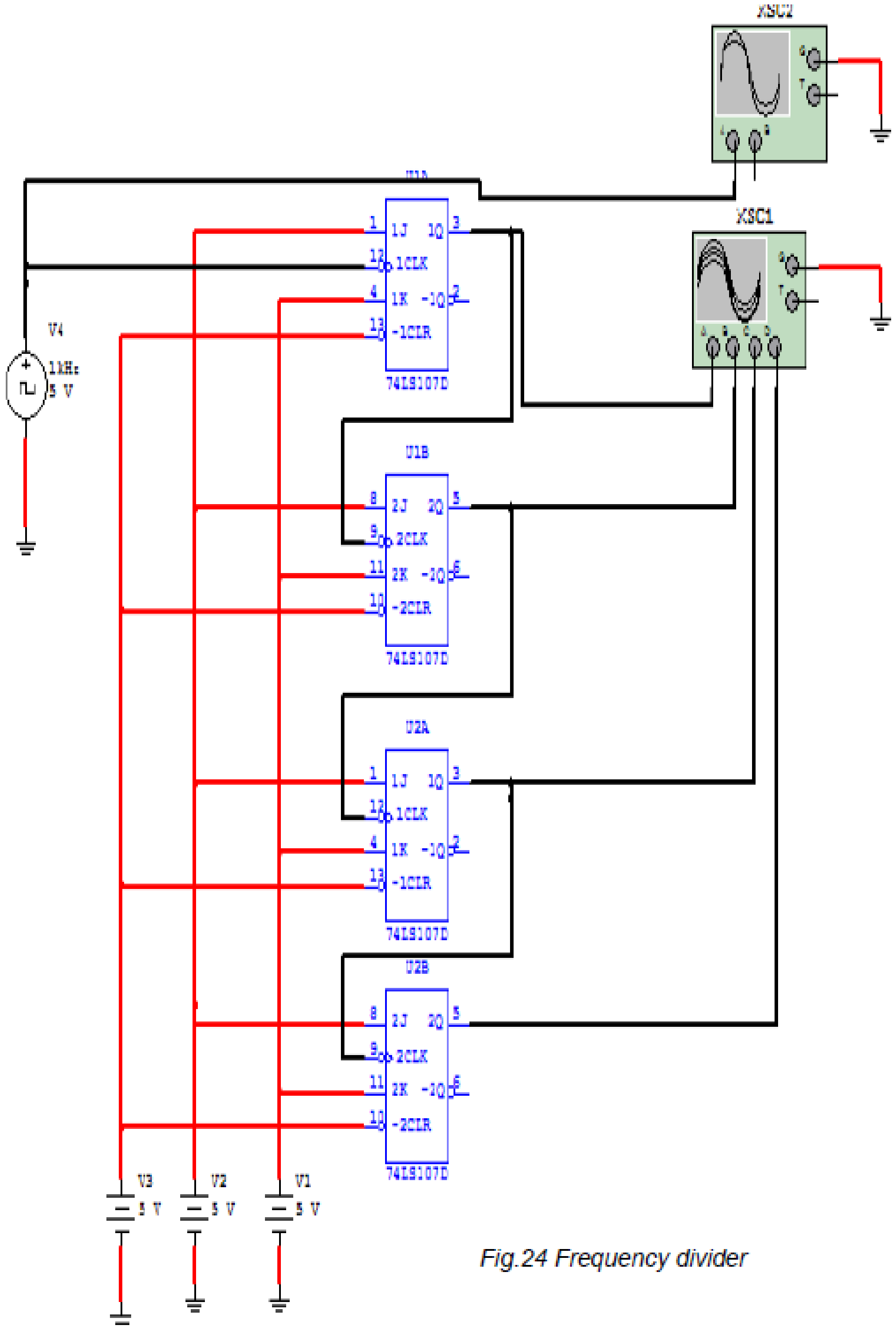


Fig.24 Frequency divider

التجربة التاسعة

.Opto-components

Experiment Title:

- Optocomponents.

Devices:

- Two channel Oscilloscope.
- Function generator.
- Dual power supply.
- Digital multimeter.
- Side cutter (قصافة).
- Pliers (زردية)
- Test board.

Pre-Request:

- Conventional diode operation.
- Special diodes.
- Photo cells.
- Photo-electric effect.

Part-II: Experiment Procedure

II.1 Common Anode Seven Segment Display

A. Required Components

- Seven LEDs.
- Seven 470-Ω resistors of 1/2 watt power rating.

B. Required Devices

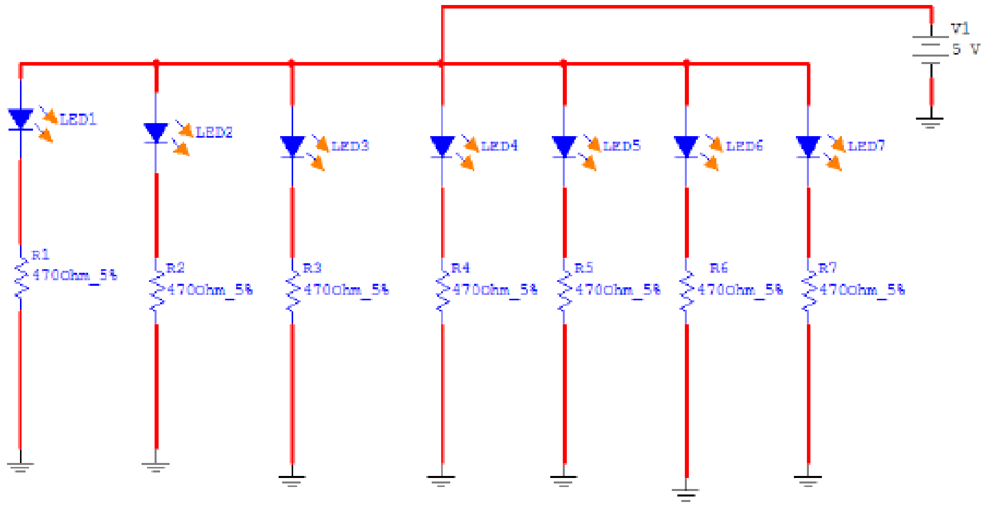
- Dual stabilized dc power supply.

C. Procedure

- Connect the circuit shown in Fig.12.
- Complete the truth table shown in Table.1.
- Give your comments.

Table.1 Seven segment truth table							
"a"	"b"	"c"	"d"	"e"	"f"	"g"	Digit
0V	0V	0V	0V	0V	5V	0V	
5V	0V	0V	5V	5V	5V	5V	
0V	0V	5V	5V	0V	0V	5V	
0V	0V	0V	5V	5V	0V	5V	
5V	0V	0V	5V	5V	0V	0V	
0V	5V	0V	0V	5V	0V	0V	
0V		0V	0V	0V	0V	0V	
0V	0V	0V	5V	5V	5V	5V	
0V	0V	0V	0V	0V	0V	0V	
0V	0V	0V	0V	5V	0V	0V	

III.1 Common Anode 7-Segment



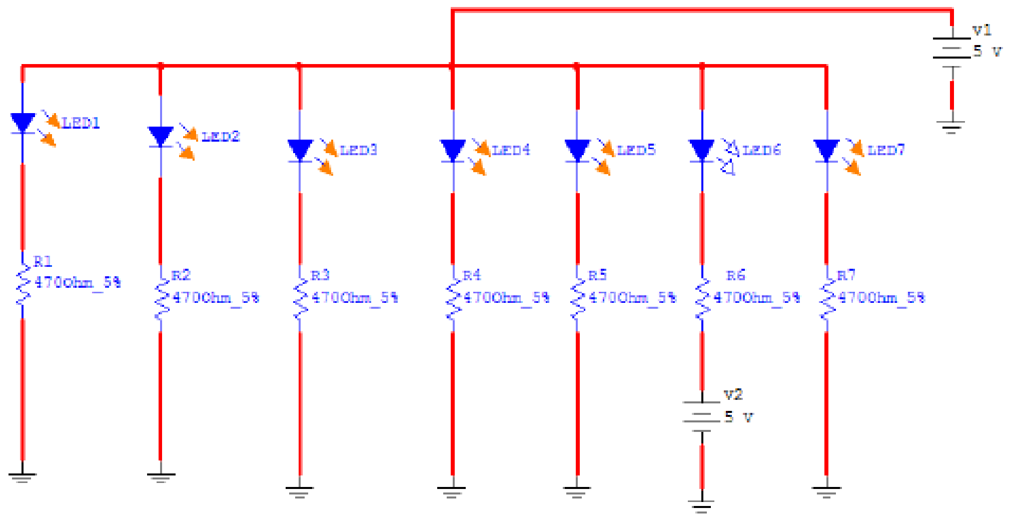


Fig.12 Common anode 7-segment

II.2 Common Cathod Seven Segment Display

A. Required Components

- Seven LEDs.
- Seven 470-Ω resistors of 1/2 watt power rating.

B. Required Devices

- Dual stabilized dc power supply.

C. Procedure

- Connect the circuit shown in Fig.13.
- Complete the truth table shown in Table.2.
- Give your comments.

Table.2 Seven segment truth table							
"a"	"b"	"c"	"d"	"e"	"f"	"g"	Digit
5V	5V	5V	5V	5V	5V	0V	0

0V	5V	5V	0V	0V	0V	0V	1
5V	5V	0V	5V	5V	5V	0V	2
5V	5V	5V	5V	0V	5V	0V	3
0V	5V	5V	0V	0V	5V	5V	4
5V	0V	5V	5V	0V	5V	5V	5
5V	0V	5V	5V	5V	5V	5V	6
5V	5V	5V	0V	0V	0V	0V	7
5V	5V	5V	5V	5V	5V	5V	8
5V	5V	5V	5V	0V	5V	5V	9

III.2 Common Cathode 7-Segment

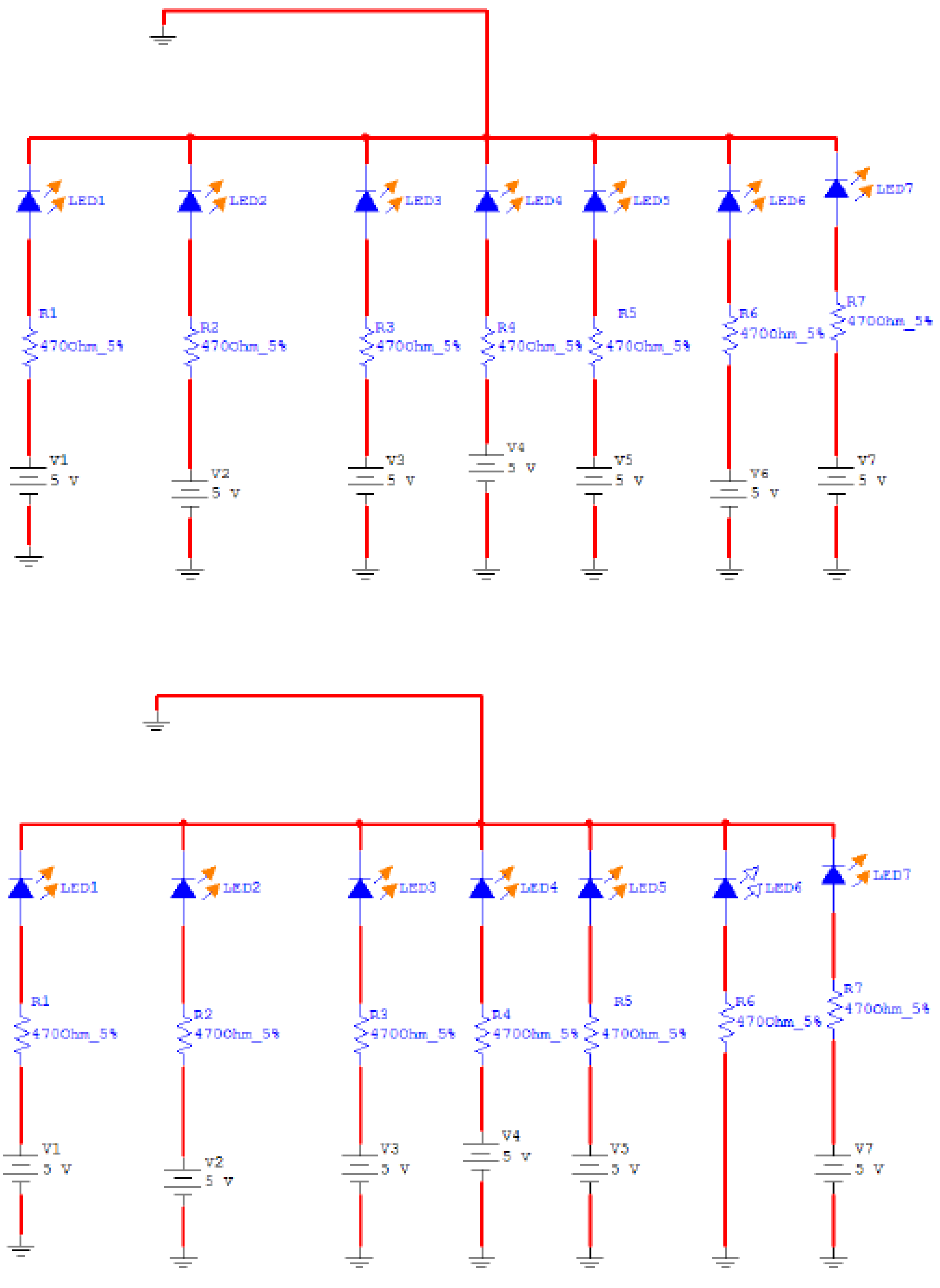


Fig.13 Common cathode 7-segment

II.3 BCD Counter with Seven Segment Display

A. Required Components

- One 74LS90 TTL BCD counter.
- One 74LS47 TTL driver.
- One common anode seven segment.
- Seven 470-Ω resistors of 1/2 watt power rating.

B. Required Devices

- Dual stabilized dc power supply.

C. Procedure

- Connect the circuit shown in Fig.14.
- Notice the digits displayed on the seven segment.
- Give your comments.

III.3 BCD Counter with 7-Segment Display

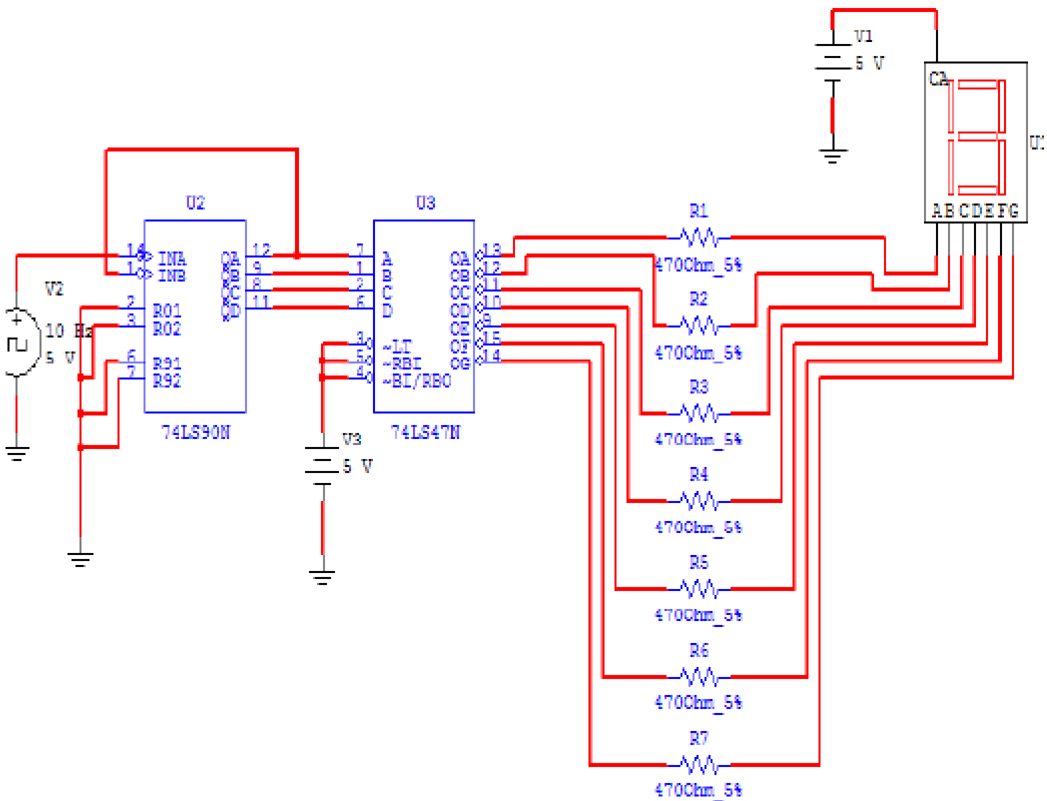


Fig.14 BCD counter with 7-segment display